

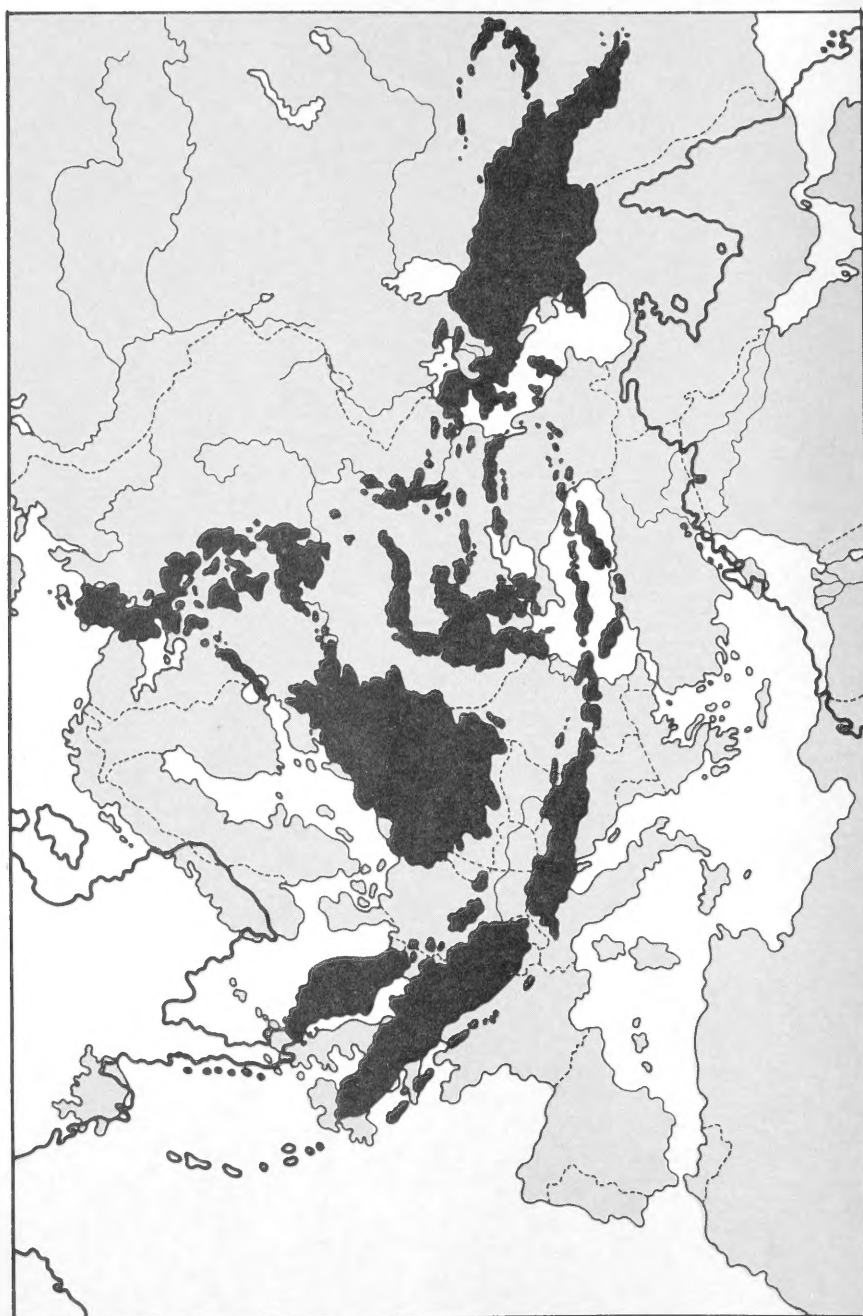
FLORA MALESIANA

SERIES I – SPERMATOPHYTA

Flowering Plants

Volume 11, part 2

*Rosaceae, Amaryllidaceae, Alliaceae
Coriariaceae, Pentastemonaceae, Stemonaceae*



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FLORA MALESIANA

SERIES I — SPERMATOPHYTA

Volume 11 — part 2 — 1993

Rosaceae

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Amaryllidaceae

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Alliaceae

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Pentastemonaceae

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Stemonaceae

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ROSACEAE

(C. Kalkman, Leiden, The Netherlands)

Rosaceae Juss., Gen. Pl. (1789) 196, nom. cons.; Hutch., Gen. Flow. Pl. 1 (1964) 174–216; Vidal, Fl. Camb., Laos & Vietnam 6 (1968) 1–210 (excl. *Rubus*); Nguyen Van Thuan, *ibid.* 7 (1968) 1–83 (*Rubus*); Vidal, Fl. Thailand 2 (1970) 31–74 (*Rubus* by Nguyen Van Thuan); Tirvengadam, Fl. Ceylon 3 (1981) 328–378. — Type genus: *Rosa* L.

Woody or herbaceous plants. *Leaves* usually spirally arranged, sometimes distichous, rarely opposite (not in Malesia), simple or compound. *Stipules* on the twig or on the base of the petiole, free or adnate to petiole, rarely absent. *Inflorescences* various. *Flowers* usually bisexual and actinomorphic. *Hypanthium* ('calyx tube' of many authors) usually very distinct, from saucer-shaped to tubular or campanulate, the sepals, petals, and stamens inserted on its rim, its inside usually lined by a nectariferous disk. *Sepals* usually 5, free, in some tribes an *epicalyx* also present. *Petals* usually 5, free, from large and showy to small and not or hardly distinct from sepals, in some genera/species absent. *Stamens* usually numerous, but sometimes the number distinctly related to the number of perianth leaves, filaments free, anthers bilocular, dehiscing longitudinally. *Pistil(s)* 1 to many, free or variously connate with each other and/or with the hypanthium, ovary(ies) superior to inferior, style(s) present, ovule(s) 1 to several (often 2) per locule, anatropous, ascending or pendulous. *Fruits* various, fleshy or dry, dehiscent or not. *Seed(s)* 1 to several, without or with scanty endosperm, cotyledons fleshy or flat.

Distribution — A large family with worldwide distribution, including more than 3000 species in c. 100 genera. Almost all genera which are represented in Malesia have their actual centre of distribution in temperate to subtropical regions on the Northern Hemisphere. Some of those are large or medium large genera with only one or two species in Malesia (*Rosa*, *Alchemilla*, *Eriobotrya*), others have a more or less distinct sub-centre in the Malesian region (*Prunus*, *Rubus*, *Potentilla*). Exceptional is *Acaena*, a genus with a Southern Hemisphere distribution, of which one species also occurs in New Guinea.

Kalkman [Bot. J. Linn. Soc. 98 (1988) 37–59] postulated a Southern (Gondwanan) origin for the family and migration via three routes. Malesia in this view was reached mainly from the Asian continent (Laurasia), which in turn was reached by way of South, Central, and North America and via Beringia. Partly maybe the continent was also reached directly from Gondwana by transport on the Indian 'raft' (*Alchemilla*?). A third route was via Australia (*Acaena*). Most authors, however, favour a Laurasian origin for the family.

Habitat — The majority of Malesian *Rosaceae* belongs to the mountain flora and occurs only above 1000 à 1500 m altitude, in montane forest types, thickets or (sub)alpine grasslands. Only in the genus *Rubus* (a dozen species) and in *Prunus* (more than 20 species) an appreciable proportion of the species are (also) found in the lowlands.

Ecology — As is true for almost all Malesian higher plant families, no autecological research has been carried out for members of *Rosaceae*. From the habitats where the species have been collected, some superficial conclusions may be drawn about preferences or tolerances for light, temperature and soil conditions and wherever possible, the paragraphs on Habitat and Ecology contain this kind of information.

Pollination is undoubtedly normally by (unspecified) insects, as in the European relatives. Apart from the formation of a good quantity of pollen and the secretion of nectar by the disc, there are no specializations in the flowers related to pollination by specific kinds of insects. Only for *Acaena* wind-pollination might be inferred, but experimental or observational evidence is lacking in literature or on labels.

For *dispersal* most *Rosaceae* rely heavily on animals. Exceptions are found in genera with multi-seeded follicles with dry seeds (in Malesia only *Neillia*) where dispersal is by ballistochory. The same is true for most of the *Potentilla* species that have the dry achenes in the cups formed by the hypanthium, sepals and epicalyx. Some genera have dry achenes, imbedded in or surrounded by a fleshy spurious fruit (*Rosa* and also the not indigenous *Fragaria* and *Potentilla indica*). In these cases the hypanthium, resp. the torus functions as the attractant for endozoochory by snails, birds, or other animals. Many *Rosaceae* of different tribes have gone the way to fruits with a fleshy or juicy layer in their walls (drupes, either single or as collective, or pomes) and obviously these are also endozoochorous. Epizoochory is only exercised by *Acaena* and *Agrimonia* which possess spines on their hypanthium in which the fruit is included.

Taxonomy and Phylogeny — In modern systems the *Neuradaceae* and the *Chrysobalanaceae* [for the latter, see Flora Malesiana I, 10 (1989) 635–678] are mostly not included in *Rosaceae*, as in earlier classifications, but recognized as families in their own right.

In the family *Rosaceae* as implied in the previous paragraph usually four subfamilies are distinguished: *Spiraeoideae*, *Rosoideae*, *Maloideae* (*Pomoideae*), and *Prunoideae* (*Amygdaloideae*). The last-mentioned two groups are undoubtedly two end-branches in the phylogenetic tree, well recognizable, distinct, and natural (holophyletic) taxa. This cannot be said for the two other subfamilies. The group *Spiraeoideae* contains the genera with dry, dehiscent fruits. Dehiscent follicles is a plesiomorphic (primitive) character in the family and the genera possessing this character should better be included in a taxon with the genera that have been derived from them. Considering the likeness of the flowers of some *Spiraeoideae* and those of some *Maloideae* like *Cotoneaster* and *Pyracantha*, I would be inclined to enlarge the subfamily *Maloideae* with at least part of the *Spiraeoid* genera.

The *Rosoideae* are quite heterogeneous and they have probably to be united with other, 'Spiraeoid', genera to form another holophyletic branch, in which maybe some subdivision is possible.

A phylogenetic analysis, only considering morphological characters [Kalkman, Bot. J. Linn. Soc. 98 (1988) 37–59] was not successful and should be repeated with an augmented set of characters, also anatomical and chemical ones. Awaiting this, the recognition of the four classical subfamilies is hardly justified.

The next lower level of classification was used by Hutchinson, l.c., who divided the family in some twenty tribes. Some of these are heterogeneous, some others contain only one or two 'difficult' genera that have not yet found a good place with their nearest relatives in the phylogenetical sense.

The firm core of a tribal classification consists of the following tribes:

- S *Spiraeae* (see p. 244)
- S *Neillieae* (see p. 245)
- S *Gillenieae* (maybe to be split into two tribes) (not in Malesia)
- R *Rubeae* (see p. 247)
- R *Potentilleae* (see p. 285)
- R *Dryadeae* (probably to be divided into two tribes) (not in Malesia)
- R *Poterieae* (see p. 297)
- R *Alchemilleae* (usually included in *Potentilleae* or *Poterieae*) (see p. 301)
- R *Roseae* (see p. 303)
- M *Maleae* (*Pomeae*) (see p. 306)
- P *Pruneae* (including *Osmaronia*?) (see p. 319)

S = tribes belonging to *Spiraeoideae* in the classical sense; R = *Rosoideae*; M = *Maloideae*; P = *Prunoideae*.

The following genera have not found a natural place in one of the eleven (or thirteen after dividing two of them) tribes mentioned above:

- the genera composing the tribe *Quillajae* in Hutchinson's classification, a rather heterogeneous assemblage of Spiraeoid problem cases: *Quillaja*, *Kageneckia*, *Exochorda*, *Lindleya*, *Vauquelinia*, *Lyonothamnus*;
- a number of lone genera of uncertain disposition as to tribe and often also subfamily: *Holodiscus*, *Rhodotypos*, *Kerria*, *Neviusia*, *Cercocarpus*, *Coleogyne*, *Filipendula*, *Potaninia*, *Adenostoma*.

None of the genera mentioned above occur in Malesia.

Morphology — As apparent from the family description, there is variation in many characters of leaves, flowers, and fruits. The presence of a well-developed hypanthium, a probably axial outgrowth from the top of the pedicel surrounding the pistil(s), is about the only character that is common to all *Rosaceae*. The elaboration of this hypanthium causes much of the variation in flowers and fruits. The plesiomorphic (original) situation is still present in Spiraeoid genera that have a small number (up to 5) multi-ovulate ovaries on the bottom of a cupular hypanthium, the ovaries developing into ventrally dehiscent, dry-walled follicles containing several seeds.

Adnation of the ovaries to the inside of the hypanthium, accompanied by a more or less complete fusion of the ovaries with each other, creates the possibility for the evolution of the fleshy, (semi-)inferior fruits that are typical for *Maloideae*. In this group the exocarp of the inferior fruit is certainly hypanthial, the endocarp (membranous to woody) is certainly carpellary, the more or less fleshy mesocarp may be either or both. In the descriptions in this treatment the terms exocarp, mesocarp, and endocarp are used in

their topographical sense, for superior as well as inferior fruits and thus not implying a carpellary origin.

Another line of evolution is the change of dry, multi-seeded follicles into dry, 1-seeded achenes, that later may develop a fleshy fruitwall and become drupaceous. Examples are manifold in *Rosoideae* (e.g. *Rubus* with many pistils per flower) and all *Prunoideae* have drupes too, with one pistil per flower.

Vegetative Anatomy — Although many papers have been published on the leaf anatomy of the *Rosaceae*, little is known of the anatomy of the tropical representatives, especially of the Malesian species. The situation for wood anatomy is much better with recent comprehensive studies by Zhang (1992), Zhang & Baas (1992) and Zhang et al. (1992). The following is a concise summary for the Malesian representatives (wild and cultivated) of data surveyed more extensively in Metcalfe & Chalk (1950) and the above-mentioned wood anatomical studies, amplified with scattered data from the other papers cited below.

Leaf anatomy. Trichomes if present usually unicellular, but tufted or stellate hairs occur in *Potentilla* p.p. and *Rubus* p.p.; stalked capitate glands have been recorded in *Alchemilla*, *Fragaria*, *Potentilla*, *Prunus*, *Rosa*, *Rubus*, and *Sanguisorba*. Epidermal cells of lower epidermis sometimes papillate.

Extrafloral nectaries present on the petiole and various parts of the leaf blade of *Prunus* p.p.; leaf teeth glandular or hydathodal in species of *Alchemilla*, *Fragaria*, *Prunus*, *Pyrus*, *Rubus*, *Sanguisorba*, and *Spiraea*. Stomata almost always confined to the lower leaf surface, usually anomocytic, but cyclocytic, staurocytic, tetracytic, and actinocytic types may also occur (Lu et al. 1991). Upper epidermal cells often (partly) mucilaginous. A hypodermis is differentiated in some species of *Prunus* ('*Pygeum*') and *Rubus* (section *Micranthobatus*). Mesophyll dorsiventral. Vascular bundles of minor veins with or without sclerenchyma in bundle sheath, only rarely vertically transcurrent. Vascular system of midrib and petiole ranging from a single collateral bundle to more complex, open or closed systems. Nodes usually trilacunar, but 5-, 7-, and 9-lacunar nodes recorded in *Rubus* (Kato 1966, 1967). Crystals solitary and/or clustered. Tanniferous cells common. Mucilage idioblasts present in the mesophyll of some species.

Wood anatomy. Growth rings faint or absent. Vessels diffuse, typically mostly solitary, but radial vessel multiples common in *Prunus* s.l., and vessel clusters fairly common in *Rubus*. Vessel frequency and diameter very variable depending on plant habit and ecology. Intervessel pits, nonvestured, alternate, ranging from minute to large (2–12 µm); vessel-ray pits usually similar but half-bordered and slightly smaller (but conspicuously smaller in *Prunus* p.p.). Helical wall thickenings present in *Rosa*, all Old World *Maloideae*, and *Prunus*, but usually weakly developed or restricted to vessel element tails in the Malesian species (as far as studied). Gummy contents common in heartwood vessels. Ground tissue fibres typically fibre-tracheids with distinctly bordered pits common in radial and tangential walls, but in *Prunus* pits mainly confined to the radial walls, and in some species (belonging to the subgenera *Amygdalus* and *Laurocerasus*) also much reduced in size so that fibres tend to the libriform type. Parenchyma typically scarce, scanty paratracheal and apotracheal diffuse; in the *Maloideae* parenchyma more abundant and sometimes diffuse-in-aggregates. Irregularly zonate parenchyma bands restricted to *Prunus*

p.p. ('*Pygeum*' and subg. *Laurocerasus* p.p.). Rays 1–3(–4)-seriate in all *Maloideae* and in *Alchemilla* (1-seriate) and *Potentilla* [1–2(–3)-seriate]; in the remaining genera (*Prunus* and most *Spiraeoideae* and *Rosoideae*) rays of two more or less distinct sizes, with the wide rays 3–8(–16)-seriate. Ray composition varying from homocellular in *Micromeles* and *Photinia* p.p.; heterocellular with one to several rows of square to upright marginal cells in *Prunus* and most Malesian *Maloideae* (Kribs' heterogeneous II & III); to largely composed of square to upright cells in all shrubby *Spiraeoideae* and *Rosoideae* (so-called 'juvenilistic rays'). Crystals absent, or present as rhomboidal crystals in ray cells (*Rosoideae* and *Spiraeoideae*) or in, usually enlarged, chambered axial parenchyma cells (*Maloideae*); in species of *Prunus* druses (subg. *Amygdalus*, *Laurocerasus* p.p., *Padus*, *Prunus*, and '*Pygeum*') may occur as well as, or instead of rhomboidal crystals (the latter are found in subg. *Laurocerasus* and *Padus*), in ray and/or axial parenchyma cells. Traumatic gum ducts sometimes present in species of *Prunus* (except species belonging to subg. *Prunus*).

The wood anatomical diversity of the *Rosaceae* lends itself well for microscopic wood identification and a contribution to phylogenetic classification of the family (Zhang 1992). The *Spiraeoideae* and *Rosoideae* are wood anatomically fairly heterogeneous but inseparable; the *Maloideae* are a very coherent group showing only very limited wood anatomical variation. *Prunus*, on the other hand is wood anatomically very diverse and several groups, largely coinciding with the present subgeneric boundaries, can be distinguished, lending some support to their treatment as separate genera: *Amygdalus*, *Laurocerasus*, *Padus*, *Prunus* s.s., and *Pygeum*. More detailed leaf and wood anatomical studies of the Malesian taxa will certainly yield much information of taxonomic significance.

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Palynology — Pollen of representatives of some 80 genera of *Rosaceae* has been studied in greater or less detail (see Tissot 1990). A comprehensive family treatment is not available up to now. Detailed regional accounts are those by Reitsma (1966), Teppner (1966) and Eide (1981) for NW Europe, and those by Hebda et al. (1988a, b, 1990, 1991) for W Canada, and by Naruhashi & Toyoshima (1979) for Japan.

Rosaceae is a stenopalynous family. The pollen grains are isopolar, radially symmetric, subspheroidal monads. The polar axis (P) is 10–60 µm (mostly 20–35 µm), the equato-

rial diameter is 10–50 μm . The *Spiraeae*, *Gillenieae*, *Holodiscus*, *Filipendula* and *Ade-nostoma* have small pollen (P usually < 20 μm). The largest grains occur in *Agrimonia* and *Mespilus* (P up to 50–60 μm).

The apertural system is generally tricolporate, though di-, tetra-, syn- and pericorporate grains may be occasionally found in tricolporate samples. Small grains have often indistinct or ill-defined endoapertures (colpate, colporoidate). Pollen of *Woronowia*, a monotypic genus included in *Sieversia* by Hutchinson (1964), is 5- (or 6-) colpate (Li 1990). Usually the colpi are relatively long, but *Polylepis* and *Cliffortia* (*Poterieae*) have brevicolpate and porate ectoapertures respectively. All *Potentilleae* have operculate ectoapertures. Opercula occur also in several genera of *Poterieae* (e.g., *Acaena*, *Agrimonia*, *Sanguisorba*), and in a number of *Rosa* species. In *Sanguisorba* spp. the opercula are as wide as the mesocolpia, which often led to describing the grains as being 6-colporate. Many rosaceous pollen grains show 'pore flaps', i.e. more or less protruding sexinous extensions of the mesocolpia arching over an endoaperture, and that occasionally may form an equatorial bridge (Hebda & Chinnappa 1990).

Exine stratification is usually distinct with light microscopy. The scarce electron micrographs published show a columellate infratectal layer. Ornamentation is mostly meridionally striate, but much variation is found in the length, height, width and pattern of the muri and lumina, and the size and number of the perforations within the lumina. *Agrimonia* and *Sorbaria* pollen is finely transversely striate. Other ornamentation types include rugulate, psilate (e.g. *Cotoneaster*), perforate-microreticulate (*Neillia*) and verrucate-scabrate (e.g., *Acaena*, *Alchemilla*, *Sanguisorba*). Many intermediate forms exist. The tribe *Poterieae* is most diverse with respect to ornamentation. The scabrate type of *Acaena* and *Polylepis* might be associated with wind-pollination. Pollen of these plants is recorded in many diagrams of lake sediments from Colombia and Venezuela (Smit 1978; Salgado-Labouriau 1979).

Obviously, *Rosaceae* pollen offers few possibilities for subdividing the family. The detailed studies of Canadian *Rosaceae* pollen allow the recognition of many pollen types (Hebda et al. l.c.), but future work must reveal whether these types have any systematic and phylogenetic significance. Very few fossil pollen has been reported, all from the Oligocene onwards (Muller 1981).

The pollen of *Chrysobalanaceae* and *Rosaceae* is readily distinguishable, but the differences are relatively small (Prance 1989). Pollen of the *Neuradaceae* is clearly different (see Erdtman 1952; Van Zinderen Bakker & Coetzee 1959).

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R.W.J.M. van der Ham

Phytochemistry — *General remarks.* Chemistry and chemotaxonomy of *Rosaceae* were reviewed twice in recent time (Hegnauer 1973, 1990). In these treatises *Chrysobalanaceae* with their characteristic seed oils were included as a subfamily in *Rosaceae*. A series of papers treating the impact of secondary metabolites, predominantly phenolic compounds, on the classification and infrafamiliar evolution of *Rosaceae* was published by Challice (1973, 1974, 1981), and a short chemotaxonomic discussion of *Rosaceae* was included in an essay of Hegnauer (1976). For the present purpose references usually will only be given for papers not cited in one of the forementioned publications.

Worldwide, many members of *Rosaceae* are highly esteemed in traditional medicine. Several recent investigations are concerned with rosaceous medicinal crude drugs, including some eastern Asiatic ones; they will be mentioned in the present phytochemical summary. Leaf phenolics are often heavily overrated in chemotaxonomic discussions (Hegnauer 1990: 373–375). They are doubtlessly valuable characters at generic and lower levels, but they should be used with extreme care only at higher hierarchic levels; tannins and isoflavonoids are perhaps the taxonomically most promising phenol classes at suprageneric levels.

Cyanogenic glycosides. Since more than 160 years amygdalin, the gentiobioside of mandelonitrile, is known from seeds of bitter almonds, and prunasin, a glucoside of mandelonitrile, was prepared in 1895 from amygdalin by cleaving off one molecule of glucose. For a thorough discussion of cyanogenesis and its possible taxonomic meaning in *Rosaceae* see Fikenscher et al. (1981). Amygdalin has been detected in seeds of many species of *Prunus* and several genera of *Maloideae*. In vegetative parts of both taxa amygdalin is usually replaced by prunasin. For a long time these two cyanogenic glycosides, which release benzaldehyde on hydrolysis, were considered to be characteristic of the family. This is true, however, only of the genus *Prunus* with the basic chromosome number ($x = 8$) and of *Maloideae* ($x = 17$). True *Rosoideae* ($x = 7$) do not produce cyanogenic compounds. The genera *Exochorda*, *Oemleria* and *Prinsepia* (all with $x = 8$ and all considered to be *Prunoideae*) have weakly cyanogenic leaves and twigs with a still unidentified cyanogenic glycoside which is not prunasin.

The *Spiraeoideae* sensu Schulze-Menz 1964 (mostly $x = 9$) are rather heterogeneous with regard to cyanogenesis. Prunasin is present in leaves of *Gillenia trifoliata*, *Spiraea prunifolia* (release of HCN and benzaldehyde; not by other *Spiraea*-taxa) and *Aruncus silvester* (also in rootstocks), and *Sorbaria*-taxa (possibly also *Chamaebatiaria millefolium*) produce heterodendrin and aromatic esters of cardiospermin. *Kageneckia* with $x = 17$ produces prunasin and resembles *Maloideae* in this respect.

A third type of cyanogenic glycosides, the tyrosine-derived dhurrin, was demonstrated to be present in *Cercocarpus* and *Chamaebatia* (both with $x = 9$), whereas in other 'rosoid' taxa with $x = 9$ hitherto unidentified cyanogenic glycosides, which do not release benzaldehyde, occur in small amounts: *Kerrieae* with *Coleogyne ramosissima*, *Kerria japonica*, *Neviusia alabamensis* and *Rhodotypos scandens*, and *Adenostomeae* with *Adenostoma fasciculatum* and *sparsifolium*. Thus *Rosaceae* use at least three pathways, the phenylalanine-route, the tyrosine-route and the leucine-route, for the production of their cyanogenic glycosides. The leucine-pathway is also known from *Mimosaceae*, *Crassulaceae* and *Sapindaceae*.

Phenolic constituents. All rosaceous plants are accumulators of phenolic and polyphenolic constituents, but the profiles of phenolics vary widely with plant parts and with taxa. Simple phenolic glycosides like arbutin [*Pyrus*, *Sorbaria*, *Adenostoma*, but not *Exochorda* (Hegnauer 1990: 374)], picein (the glucoside of 4-hydroxyacetophenone; bark of *Amelanchier* p.p.), gein (vicianoside of eugenol; *Geum* s.l. p.p.), sweet-tasting dihydrochalcone glucosides phloridzin, sieboldin and trilobatin [*Pyrus* and according to Challice (1974) *Docynia* and *Sorbaria*, but not *Adenostoma*] and the glycosidic derivatives of salicylic acid monotropitin and spiraein (*Filipendula*) are taxonomic markers of the genera mentioned or at least of a number of their species.

The closely related species *Prunus laurocerasus* (prunasin) and *P. lusitanica* (lusitanicoside, the rutinoside of the monophenolic phenylpropanoid chavicol) can easily be discerned by their major leaf constituents mentioned, and the glucosidic phloracetophenone derivative domesticoside was hitherto only isolated from the bark of *Prunus domestica*. Mahaleboside is a 5-glucosyloxy coumarin of *Prunus mahaleb*; coumarin, herniarin and a number of 5-hydroxylated and O-methylated coumarins, such as tomentin and fraxinol, seem to be rather characteristic bark constituents of certain *Prunus* species. Biologically active acylphloroglucinol derivatives occur in flowers of *Hagenia abyssinica*, which were formerly used as taenifugum (kosotoxin, protokosin), and in the Chinese medicinal plant *Agrimonia pilosa* (agrimophol and the agrimols A–C).

Lignans (Ayres & Loike 1990) were isolated from *Maloideae* [9'-xyloside and 9'-rhamnoside of (+)-lyoniresinol: *Sorbus aucuparia*, *Cotoneaster depressus*] and from *Prunoideae* [prinsepiol, a furofuranoid lignan from *Prinsepia utilis* and pygeoside, the 9'-xyloside of (-)-lyoniresinol from *Pygeum acuminatum*]. For aucuparin-like biphenyls see under phytoalexins.

Many more genus- or species-characteristic simple phenolic compounds and their glycosides could be listed without difficulties, but at higher taxonomic levels (tribes, subfamilies, family) hydroxybenzoic acids, hydroxycinnamic acids, flavonoids and tannins are the predominant classes of phenolic constituents.

Bate-Smith (1961, 1962, 1965) showed, that *p*-coumaric and caffeic acid (= 4-hydroxy- and 3,4-dihydroxycinnamic acid), the flavonols kaempferol and quercetin and cyanidin generated from procyanidins (condensed tannins) occur widely in rosaceous leaf hydrolysates, that trihydroxylation of the B-ring of flavanoid compounds (e.g. myricetin, prodelphinidins) is rare, and that ellagic acid indicating presence of ellagitannins is restricted to true *Rosoideae* ($x = 7$). Moreover, Bate-Smith already noted incidental presence of flavones (apigenin, luteolin) and 6-hydroxylated flavonoids (quercetagenin) in the family.

The screening for rosaceous leaf phenolics was much extended by Challice. He showed general occurrence of 3-caffeoylquinic acid (chlorogenic acid) and restriction of mixtures of dicaffeoylquinic acids, known as isochlorogenic acid, to many genera of *Maloideae*, inclusive of sections *Aria* and *Aucuparia* of *Sorbus* and of *Lindleya*. At this point the nonphenolic cinnamic acid should be mentioned. It occurs in large amounts in hydrolysates of several species of *Spiraea*; originally it is present as cinnamoyl- β -glucopyranose and an acylated derivative, spirarin. Benzoylglucose was isolated from *Luetkea pectinata*. Challice

stressed the taxonomic importance of flavone-C-glycosides within *Maloideae*, including *Dichotomanthes*, and the rather sporadic occurrence of these metabolites elsewhere in the family.

As already mentioned, the presence of isoflavones in *Rosaceae* may be taxonomically rewarding, because they possibly indicate affinities with *Leguminosae* [see for isoflavones the treatment of *Mimosaceae* in Flora Malesiana 11 (1), p. 19]. The isoflavones genistein, prunetin, biochanin-A and their glucosides prunitrin (prunetin-4'-glucoside), prunetinoside (prunetin-5-glucoside) and biochanin-A-7-glucoside have not yet been traced as leaf constituents; they were isolated from wood and bark of several species of *Prunus*, from fruit stalks of *Prunus avium* and *P. cerasus* and from flowers and fruits of *Cotoneaster pannosa* and *serotina*. Many more peculiar flavonoids including flavanones (e.g. Bilia et al. 1991), flavanonols (e.g. Yoshida et al. 1989a), the 8-methoxyflavonols sexangularetin and corniculatusin which occur in *Dryas octopetala*, *Cowania mexicana* and *Purshia glandulosa* (all *Dryadeae* with $x = 9$), many more O-methylated flavonoids, tricetin, a flavone with a 3',4',5-trihydroxylated B-ring (*Luetkea pectinata*), and even 2-phenoxychromones (Hashidoko et al. 1991a) are produced by *Rosaceae*. For more information about the multiformity of flavonoid metabolism in the family and its possible taxonomic meaning see Challice (1981) and Hegnauer (1973, 1990). The most conspicuous rosaceous hydroxybenzoic acid is gallic acid (3,4,5-trihydroxybenzoic acid); it will be mentioned under tannins.

Tannins (compare also *Mimosaceae* treatment). Proanthocyanidins (condensed tannins) seem to be more or less ubiquitous in leaves, flowers, fruits, stems and roots of *Rosaceae*; they are accompanied by their monomeric building stones (+)-catechin and (-)-epicatechin and many (4-8)- and (4-6)-linked catechin dimers and trimers with low tanning activity; the proanthocyanidins with strong tanning action are assumed to be usually tetramers and higher oligomers.

Double-linked A-type procyanidins are known from the bark of *Rhaphiolepis umbellata* and from *Prunus spinosa*. (+)-Gallocatechin and prodelphinidins which are rarely present in leaves seem to occur more often in 'tannin'-fractions of fruits (*Maloideae* p.p.) and roots (*Sanguisorba officinalis*, *Potentilla erecta*). *Purshia tridentata* and *Coleogyne ramosissima* yielded about 3% of true condensed tannins (average mol.wt. 13-1400, i.e. tetra- to pentamers) from winter dormant twigs of current season growth; the tannins of the two taxa differed in stereochemistry and biological activity (Clausen et al. 1990). The *Purshia* tannin was found to have a catechin/epicatechin-ratio of about 55:45 and to be preferred by snowshoe hares in a choice feeding bioassay to the *Coleogyne* tannin, which is predominantly based on epicatechin. This shows that the always highly complex condensed tannin-fractions may have an extremely diverse spectrum of biological activities which depend on hydroxylation patterns and stereochemistry of their building stones, on the nature and stereochemistry of interlinkages in the oligo- and polymers and on degrees of polymerisation.

In true *Rosoideae* ($x = 7$) the situation is even more complex, because in these plants condensed tannins are accompanied by gallo- and ellagitannins, and because catechins may also be linked with other aromatic metabolites; the pilosanols-A to -C are antimicrobial

compounds of *Agrimonia pilosa* in which C-8 of (-)-epicatechin is combined via a methylene group with acylphloroglucide residues (Kasai et al. 1992). In recent times hydrolysable tannins were thoroughly investigated for a number of medicinally used crude drugs. Examples from *Rosaceae* are roots of *Rosa davurica* (Yoshida et al. 1989a, 1991), hips and fresh leaves of *Rosa laevigata* (Yoshida et al. 1989b), petals of *Rosa rugosa* (Hatano et al. 1990), petals of 'apothecary's rose' (Eugster & Märki 1991), *Alchemilla* Folium (mainly *Alchemilla xanthochlora*), which seems to contain only hydrolysable tannins (Geiger 1991), and *Tormentillae Radix* which is rich in condensed tannins, but also contains ellagitannins (Geiger 1991) and which derives from *Potentilla erecta*.

Root cultures of *Sanguisorba officinalis* yielded gallic acid, (+)-catechin, (+)-gallo-catechin, procyanidin-B3, three gallotannins (2,8%) and the ellagitannins pedunculagin, sanguiin-H6 (up to 5,9%) and sanguiin-H11 (up to 2,3%) and 4,6-hexahydroxydiphenoylglucose (Ishimaru et al. 1990). Strawberries (*Fragaria* × *ananassa* cv. Kent) and raspberries (*Rubus idaeus*) contain small amounts of ellagitannins, and casuarictin was isolated from strawberries (Daniel et al. 1991).

Lamaison et al. (1990) investigated 42 rosaceous taxa representing all four traditional subfamilies for tannin content and observed a range from 1,7 (flowers of *Kerria japonica*) to 25,1% (roots of *Potentilla erecta*); they demonstrated that biological activity measured by inhibition of the pancreatic endopeptidase enzyme elastase is not correlated with tannin concentration. Most active tannins were found in flowers and leaves of *Alchemilla xanthochlora*, flowers of *Filipendula ulmaria*, aerial parts of *Geum montanum* and *G. rivale* and leaves of *Sanguisorba minor*, all true *Rosoideae* with $x = 7$ and usually containing both condensed tannins and hydrolysable gallo- and ellagitannins. This is another indication for the pluriformity of biological activities of individual tannin components. Finally it should be mentioned that trimethylellagic acid was isolated from rhizomes of *Sanguisorba officinalis*, because ellagic acid methylethers are usually conceived as taxonomic markers of *Myrtales*; they also occur in *Euphorbiaceae*.

A most recent publication of Okuda et al. (1992) confirms confinement of ellagitannins to *Rosoideae* with $x = 7$, including *Filipendula* (!); moreover, oligomeric ellagitannins are assumed to show a genus-specific distribution: sanguiin-H6 and -H11 in *Sanguisorba* and *Rubus*, gemin-A in *Geum* s.l., agrimoniin in *Agrimonia*, *Fragaria* and *Potentilla* and rugosin-D in *Filipendula*; this publication considers leaf tannins only. For fruits, restriction of ellagitannins to *Rosoideae* was shown by Foo & Porter (1981).

Sugars and hexitols. Saccharose is present in all *Rosaceae* in appreciable amounts; it is an easily metabolised temporary carbohydrate reserve and is used for the transport of carbohydrates. In *Prunoideae*, *Maloideae*, most *Spiraeoideae* in traditional circumscription and in *Kerrieae* and *Adenostomeae* part of saccharose is replaced by the hexitol sorbitol (= glucitol) which got its name from *Sorbus aucuparia*, one of the first and best sources of this sugar alcohol. Lack of appreciable amounts of sorbitol is a character of the ellagitannin-producing true rosoids inclusive of *Dryadeae-Geinae*, all with $x = 7$. In this respect part of *Dryadeae* sensu Schulze-Menz (1964), i.e. *Dryadinae* and *Cercocarpinae* both with $x = 9$, seem to agree better with true *Rosoideae* ($x = 7$) than with *Spiraeoideae* and *Kerrieae* with $x = 9$.

Waxes and other lipids. Rosaceous cuticular waxes of leaves and fruits (*Maloideae*) usually are rich in free pentacyclic triterpenic acids. Ursolic and oleanolic acid and a num-

ber of hydroxylated derivatives (e.g. maslinic and pomolic acid) were isolated from leaves and pomes of many taxa. Barks of *Rosaceae* often contain free and/or esterified pentacyclic triterpenic alcohols and ketones; lupeol, betulin, 23-hydroxybetulin (sorbicortol-B), taraxerol, alnusenol (= glutinol), friedelanol, alnusenone (= glutinone), friedelin and others were isolated from several taxa. Moreover, barks also contain free and esterified triterpenic acids; examples are pyracenic acid (betulinic acid-3-coumarate) from *Pyra-cantha crenulata* and betulinic and 3-epibetulinic acid from *Spiraea cantoniensis*. Most non-glycosylated bark triterpenes are probably constituents of cork waxes. Besides triterpenes, lipid fractions of all plant parts contain alkanes, alkenes, alkanols, long-chain fatty acids and mixtures of phytosterins.

Saponins and pseudosaponins. Saponins are widespread in the family. The sapogenins are usually derivatives of pentacyclic triterpenes, mostly ursolic acid, but sometimes oleanolic or betulinic acids. Three types of sugar attachment to the sapogenins occur: 3-glycosides, esters of the 28-carboxyl group, and the bisdesmosidic saponins which have both linkages. Compounds which have only the ester-linkage were called pseudosaponins by French authors, because their properties are different from those of 3-glycosides (true saponins); tormentol or tormentoside (= rosamultin) is such a pseudosaponin which occurs in many true *Rosoideae* ($x = 7$) and in some *Maloideae*, but could not be detected neither in *Prunoideae* and *Spiraeoideae* nor in *Kerrieae*; it is the 28-COOH glucose ester of tormentillic (= tormentic) acid ($2\alpha,19\alpha$ -dihydroxyursolic acid) and seems to combine easily with condensed tannins to antibiotically active adducts.

As a rule saponins are complex mixtures of closely related compounds. Since a long time quillajasaponin is known; it occurs in the bark of *Quillaja saponaria* which is commercially available (Soap bark) and is (was) mainly used as a non-ionic detergent (soap substitute). Presently quillajasaponin is known to be a mixture of bisdesmosidic compounds of complex structure which have quillaic acid (= 16-hydroxy-23-oxo-oleanolic acid) as sapogenin and are acylated in the sugar part by two molecules of 3,5-dihydroxy-6-methyloctanoic acid (a normonoterpenoid compound).

The Japanese crude drug *Sanguisorbae Radix* (= 'Ziyu') gathered from *Sanguisorba officinalis* yielded the 3-arabinoside of pomolic acid (ziyu-glycoside-II) and its bisdesmosidic derivative ziyu-glycoside-I which has its 28-carboxyl esterified with glucose. In recent time the pseudosaponins of leaves of Japanese *Rubus*-taxa were investigated thoroughly. The 28-COOH glucose esters of the ursolic acid derivatives acuminatic (= euscaphic) acid, 19-hydroxyasiatic (= 23-hydroxytormentillic) acid and the 3-epimer of 19-hydroxyasiatic acid could be isolated from *R. microphyllus* ('Niga-ichigo'; yielded the niga-ichigosides-F1 to -F3), *R. trifidus* ('Kaji-ichigo'; yielded the kaji-ichigosides-F1 and -F2), *R. koehneanus* (niga-ichigoside-F1 and -F2) and *R. × medius*, a *trifidus* hybride (niga-ichigoside-F2 and kaji-ichigoside-F1). Moreover, roots of the Chinese *R. suavissimus* contain niga-ichigoside-F1 and suavissimoside-R1, which is a 28-COOH glucose ester of a derivative of 19-hydroxyasiatic acid (23-CH₂OH oxidized to 23-COOH). Niga-ichigoside-F1 was also isolated from *Geum japonicum* and from hips of *Rosa sterilis*. Russian *Sanguisorba minor* s.l., i.e. *Poterium lasiocarpum* and *P. polygamum*, yielded a pseudosaponin with caccigenin ($2\alpha,21\beta,23$ -trihydroxyoleanolic acid) as sapogenin.

Recent investigations of leaves of *Eriobotrya japonica* (Liang et al. 1990; De Tommasi et al. 1992), *Potentilla fruticosa* (Ganenko & Semenov 1989), hips of *Rosa davurica* (Kuang et al. 1989), fruits of *Rubus coreanus*, *crataegifolius* and *parvifolius* (Ohtani et al. 1990), whole plants of *Rubus ellipticus* (Pal et al. 1991) and root bark or roots and aerial parts of *Sarcopoterium spinosum*, *Sanguisorba minor* s.l. and *officinalis*, and species of the endemic Canary Island genera *Bencomia*, *Marcetella* and *Dendriopoterium* (Reher et al. 1991; Reher 1991) for pentacyclic triterpenes and their pseudosaponins and saponins yielded taxonomically remarkable results. For instance, *Sanguisorba officinalis* which only contains the ziyu-glycosides-I and -II and some recently detected other derivatives of pomolic acid (Cheng & Cao 1992) is distinct from all investigated members of subgenus *Poterium*, *Sarcopoterium spinosum* and the Canary Island endemics, which all produce 23-hydroxytormentillic acid and its 28-ester glucoside (= niga-ichigoside-F1).

Rubus coreanus is distinct from other eastern Asiatic species of *Rubus* by having 0.14–0.25% coreanoside-F1, a dimeric pseudosaponin, in leaves and fruits (Ohtani et al. 1990). Leaves and fruits of *Rubus foliolosus* do not contain pseudosaponins, but a mixture of goshonosides (see sub diterpenes; Ohtani et al. 1990). The triterpene (and sesquiterpene) glycoside profiles of leaves of *Eriobotrya japonica* growing in China are different from those of plants growing in Italy (Liang et al. 1990; De Tommasi et al. 1990, 1991, 1992). *Rosaceae* also produce tetracyclic dammarane- and cucurbitane-type triterpenes. They were detected in leaves and twigs of *Cowania mexicana* (dammarenediol-II) and *Cercocarpus intricatus* (isofouquierol) and in fruits of *Purshia tridentata* (bitterbrush; the intensely bitter cucurbitacins-D and -I; occur possibly also in other parts of the plant); all three taxa belong to *Dryadeae-Cercocarpinae* and *-Purshiinae* with $x = 9$.

Diterpenes. Isoprenoid C₂₀-compounds seem to be rather rare in the family. They occur in *Spiraea japonica* and *koreana* as atisane-type diterpene alkaloids (spirasines, spiramines, and others). In the genus *Rubus* several eastern Asiatic species were shown to produce large amounts of C₂₀-glycosides in leaves instead of the usual pseudosaponins. The Chinese *Rubus suavissimus* contains the intensely sweet-tasting kauranoid steviol-13,18-bisglucoside rubusoside. From *R. chingii*, a species also occurring in Japan, where it is called 'Gosho-igicho', non-sweet labdanoid mono- and bisglucosides, the goshonosides-F1 to -F5, were isolated; such diterpenes also occur in fruits of the respective species (Ohtani et al. 1990), whereas their roots contain pseudosaponins (e.g. *R. suavis-simus*).

Seed reserves. *Rosaceae* store mainly proteins and fatty oils in their seeds; starch is absent. The seed oils belong to a 'normal' type with oleic and linoleic acids as main fatty acids; saturated acids (mostly palmitic) usually approximate 10–15%. Some species of temperate regions (*Filipendula ulmaria*, *Sanguisorba minor*, *Rosa* p.p.) have linolenic acid as a third main fatty acid. Reher (1991) found a 18:3/18:2-ratio of 1.4–2.4 in *Potentilleae* and of 0.4–1.0 in *Sanguisorbeae*. Some species of *Prunus*, notably *P. africana* (= *Pygeum africanum*), *P. mahaleb*, *spinulosa*, *undulata* and *yedoensis* and others, deviate from the patterns mentioned by having octadeca-9,11,13-trienoic (= elaeostearic) acid as a main fatty acid and resemble in this respect *Chrysobalanaceae*.

Miscellaneous. *Rosaceae* produce and store many more classes of metabolites. Examples are:

(a) Non-volatile organic acids, such as the ubiquitous malic, citric and succinic acids, and ascorbic acid (= vitamin C) which is present in large amounts in the hips of many species of *Rosa*. Isocitric acid which is seldom present in appreciable amounts in plants is stored in leaves of most investigated species of *Rubus*.

(b) Some species with glandular hairs produce essential oils containing mostly mono- and sesquiterpenoid constituents. Such essential oils are also deposited in the wood of certain species of *Prunus*. The best known 'volatile oils' of *Rosaceae* are rather products of hydrolysis of glycosides than true essential oils and usually consist for over 90% of one or two compounds, e.g. bitter almond oil (benzaldehyde from prunasin and amygdalin), methylsalicylate and salicylic aldehyde (from monotropitin and spiraein), eugenol (from gein), chavicol (from lusitanicoside) and *Sorbus aucuparia* fruit oil, which consists of antibiotically active parasorbic acid, the lactone of 5-hydroxy-2-hexenoic acid (= 2-hexene-5-olide); parasorbic acid is not present as such in the bitter fruits and seeds of *Sorbus* species of section *Aucuparia*, but as the glucosidic bitter precursor parasorboside, which is 3-glucopyranosyloxy-5-hexanolide, and seems to be a chemical marker of *Sorbus* section *Aucuparia*. The very expensive true oil of rose is produced from fragrant flowers of several taxa of *Rosa* and contains predominantly the monoterpenic alcohols citronellol, geraniol and nerol and appreciable amounts of phenylethylalcohol; in fresh young petals these alcohols are present as glycosides. Glycosides of alcoholic mono- and sesquiterpenes seem to be rather common in the family; some recent examples are leaves of *Eriobotrya japonica* (De Tommasi et al. 1990, 1992) and leaves of *Spiraea cantoniensis* (Takeda et al. 1990).

(c) Characteristic constituents of fruit aromas, such as raspberry (*Rubus idaeus*), strawberry (*Fragaria*), quince (*Cydonia oblonga*), apples (*Malus*) and cherries (*Prunus*); in fresh fruits glycosidic precursors may be present.

(d) Nitrogen-containing constituents like the proline derivatives of *Malus* and other *Maloideae* and the amines present in the foetid flower smell of some rosaceous taxa (e.g. *Crataegus* p.p., *Sorbus* p.p.). According to Strack (1990) *Rosaceae* are characterized by the production of N,N,N-tricoumaroylspermidine in flowers, especially in their androecia.

From a taxonomic point of view metabolites mentioned sub (a) to (d) are unimportant at suprageneric levels, if the triacyl derivatives of spermidine are excluded. It seems therefore to be more rewarding to finish this short chemical survey with a few remarks on phytoalexins and recent publications on *Prunus* constituents.

Phytoalexins. Phytoalexins are antibiotically active compounds produced by plants after stimulation by infections or similar stresses. Phytoalexins became known from *Rosaceae* only recently. The chemical nature of phytoalexins produced by a taxon depends to some extent on the triggering agents and the plant parts. Nevertheless some taxonomically interesting trends can be discerned in *Rosaceae*. *Maloideae* tend to produce aromatic phytoalexins based on the biphenyl and benzofuran skeleton. The biphenyls aucuparin, 4'-methoxyaucuparin and raphiolepin are produced in infected sapwood or bark of *Malus pumila*, *Eriobotrya japonica* and in stressed leaves of *Eriobotrya japonica* and *Raphiolepis umbellata*, and the biogenetically related benzofurans α -, β - and γ -pyrufurans, coto-nefuran and eriobofuran were extracted from infected sapwood of *Pyrus communis* and

Cotoneaster lacteus and from diseased leaves of *Eriobotrya japonica* (Kemp & Burden 1986; Watanabe et al. 1982, 1990; Miyakado et al. 1985). Phenylpropanoid sapwood phytoalexins are the coumarin scopoletin of *Prunus domestica* and the lignan iso-olivil from *Prunus jamasakura* (Kemp & Burden 1986). Benzoic acid was shown to be the antifungal compound produced after infection by *Nectria galligena* in apples of cv. Bramley's Seedling; it can prevent or retard fruit rotting during storage (Swinburne 1973).

Usually the production of phytoalexins is connected with necrosis of attacked cells. Sapwood phytoalexins are comparable to compounds present in heartwoods which only contain dead wood parenchyma cells. Aucuparin, for instance, occurs in heartwood of all investigated species of *Sorbus* sect. *Aucuparia*. Moreover, what is known as a phytoalexin from one plant part may be a normal constituent of perfectly healthy tissues of another part of the same plant or of other plants, e.g. the coumarin scopoletin, the lignan iso-olivil and benzoic acid. Lastly, the definition of phytoalexin is rather vague; small amounts of a given phytoalexin of a given taxon may be present in its healthy tissues. Therefore triggering of intensified synthesis of a compound by stress is included by some authors in the phytoalexin concept. Scopoletin in bark of *Prunus domestica*, coumarin and biogenetically related compounds in leaves of *Prunus mahaleb* and glycosides of gentisic acid in wood and bark of *Prunus yedoensis* are examples of 'phytoalexins' which are already present in small amounts in healthy plant parts. *Chondrostereum purpureum* infection induced not only synthesis of aucuparin, but also of 2-dehydrotomentillic acid in sapwood of *Malus pumila* (Kemp et al. 1985).

Isoprenoid phytoalexin-like compounds were also isolated from damaged leaves of *Rosa rugosa* (Hashidoko et al. 1989); they were shown to be watersoluble sesquiterpenes with the carotane skeleton and named rugosal-A (strongly fungitoxic) and rugosic acid-A (scarcely fungitoxic); both are monohydroxy-endoperoxides which bear an aldehyde resp. carboxyl group. Later the same authors reported, that leaf tissues contain a labile precursor, carota-1,4-dienealdehyde which on autoxidation yields rugosal-A and rugosic acid-A (1990), and that leaves additionally produce many more carotane type sesquiterpenes together with acaranol and bisabolanol oxygenated C₁₅-compounds (1991b, c). Finally Hashidoko et al. (1992) observed that rugosal-A and rugosic acid-A are present in the exudate of the glandular trichomes of *Rosa rugosa* leaves. The last mentioned observations suggest that rugosal-A is not a true phytoalexin, but a compound generated by autoxidation from genuinely present precursors.

Recent phytochemical investigations with Prunus-taxa:

Subg. *Prunus* — *Prunus spinosa*: Phenolics of flowers (Kolodziej et al. 1991), fruits (Ramos & Macheix 1990) and branches (Crespo Ibizar et al. 1992; González et al. 1992).

Subg. *Amygdalus* — *Prunus davidiana*: (+)-Catechin and two flavanone glycosides, prunin and hesperetin-5-glucoside, from stems (Choi et al. 1991).

Subg. *Cerasus* — *Prunus avium* and *cerasus*: Comparative investigations of inner bark and seedlings for flavonoids, and detection of prunetin-5-glucoside and tectochrysin-5-glucoside as chemical markers of *P. cerasus* and of dihydrowogonin-7-glucoside and chrysin-7-glucoside as main flavonoids of *P. avium*; both species have genistein-5-glucoside (Geibel et al. 1990, 1991). *Prunus serrulata* Lindl., a cultigen, yielded 6-caffeoylglucopyranoside and 1,6-dicaffeoylglucopyranoside (Ali et al. 1989). Its var. *spontanea*

(= *P. jamasakura*, the wild Japanese mountain cherry) has bitter fruits with prunasin as main bitter principle (Shimazaki et al. 1991); catechins, sakuranetin-5-glycosides, and the lignanoid compounds sakuraresinol, dihydrobuddlenol-B and racemic lyoniresinol were isolated from its bark (Yoshinari et al. 1990). Fruits of *P. maximowiczii* are also bitter; they contain bitter tetra- to hexaacylsucroses (acyl = one paracoumaroyl + three to five acetyl residues), epicatechin and a little mandelic acid, but no prunasin (Shimazaki et al. 1991).

Subg. *Padus* — Fresh bark of *P. buergeri* yielded no flavonoids, but mono- and bi-acylated glucopyranoses (caffeic and paracoumaric acid), the 6-caffeoylglucoside of mevalonolactone, and a little grayanin (Shimomura et al. 1988, 1989a). Bark of *P. grayana* is also free of flavonoids, but contains several caffeic, coumaric and 3,4,5-trimethoxybenzoic acid esters of glucopyranose, the grayanosides-A and -B and the strongly bitter grayanin which is prunasin with OH-6 of its glucose acylated by caffeic acid (Shimomura et al. 1987). Heartwood of *P. grayana* yielded taxifolin, dehydrodicarthechin-A, the salicin derivatives populin, henryoside and pruyanaside-B and the complex salicylic acid derivatives virgaureoside and pruyanaside-A (Shimomura et al. 1989b). Leaf wax of *P. grayana* contains the antioxidative prunosols (Osawa et al. 1991). The bitter barks of *P. padus* and *P. ssiori* contain catechins, bitter prunasin and bitter lignanxylosides lyoniside and ssioriside, and schisandriside in *P. ssiori* and prupaside in *P. padus*; moreover, *P. ssiori* yielded syringin and glucosyringic acid, and *P. padus* melilotoside and bitter tetra- and penta-acylated sucroses (Yoshinari et al. 1989, 1990).

Subg. *Laurocerasus* — From green fruits of *P. laurocerasus* Weinges et al. (1991) isolated the primveroside of benzylalcohol.

The *Prunus*-investigations just mentioned demonstrate clearly the enormous intrageneric variation of phenolic profiles and suggest once again that most phenolics are taxonomically useful above all at species, section and genus levels.

Summarizing it can be stated that secondary metabolites and seed oils can help a lot to arrive at a satisfying infrafamiliar classification, but procure only vague indications concerning family affinities [*Chrysobalanaceae*, *Crassulaceae* (phenolics, leucine-derived cyanogenic compounds), *Leguminosae*, *Sapindaceae*].

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R. Hegnauer

Uses — The usefulness of the *Rosaceae* is mainly to be found in the presence of many edible, and often delicious fruits. See: *Eriobotrya*, *Fragaria*, *Malus*, *Prunus*, *Rubus*, *Pyrus*.

Timber hardly enters the world market, but may well be useful on the local scale.

Medicinal uses appear to be scarce in the region judged from label data and Malesian literature. These sources may not give a complete picture considering the extensive use made of Rosaceous species in traditional medicine in East Asia (see also the chapter on phytochemistry, p. 233).

KEY TO THE GENERA

- | | |
|---|------------------------------|
| 1a. Leaves simple, entire or lobed. | 2 |
| b. Leaves compound, pinnate, palmate, or 3-foliolate. | 15 |
| 2a. Herbs. | 3 |
| b. Woody plants, trees or shrubby. | 4 |
| 3a. Flowers small, with epicalyx, without petals, with 1–5 stamens. Achenes enclosed in hard hypanthium | Alchemilla (p. 301) |
| b. Flowers usually showy, without epicalyx, petals only in few species absent, stamens numerous. Drupes cohering and forming a collective fruit | Rubus (p. 247) |
| 4a. Ovary or ovaries superior, not connate with the hypanthium | 5 |
| b. Ovary inferior or semi-inferior, carpels connate with the hypanthium, either entirely or at least their lower half. | 8 |
| 5a. Flower with 1 pistil (exceptionally 2) | 6 |
| b. Flower with more than 2 pistils. | 7 |
| 6a. Small shrubs. Leaves 3-lobed. Glands on the hypanthium outside, elongating after anthesis. Fruits dehiscent, with several seeds | Neillia (p. 245) |
| b. Trees or shrubs. Leaves not lobed. Hypanthium without long-stalked glands. Fruit a drupe with 1 stone | Prunus (p. 319) |
| 7a. Plants climbing, straggling, or creeping, rarely erect, usually armed. Stipules present. Fruits cohering as a collective, each of the juicy drupes with one stone | Rubus (p. 247) |
| b. Erect shrubs, not armed. Stipules absent. Fruit a dehiscent follicle with several seeds (cultivated) | Spiraea (p. 244) |
| 8a. Simple racemes. | 9 |
| b. Racemes branched and compound | 10 |
| 9a. Styles free. Fruits with stone-cells in mesocarp (cultivated) | Pyrus (p. 317) |
| b. Styles connate at base. Fruits without stone-cells (cultivated) | Malus (p. 310) |
| 10a. Plants with thorns (cultivated) | Pyracantha (p. 316) |
| b. Plants without thorns | 11 |
| 11a. Upper rim of hypanthium and sepals persistent on the fruit. Ovary semi-inferior | 12 |
| b. Sepals and upper rim of hypanthium deciduous after flowering, leaving a scar on top of the fruit. Ovary inferior. | 14 |
| 12a. Main nerves terminating in the margin | Eriobotrya (p. 308) |
| b. Main side-nerves not terminating in the margin | 13 |
| 13a. Flower with 2 carpels, in their basal half adnate to the hypanthium, but free from each other (cultivated) | Cotoneaster (p. 308) |
| b. Flower with up to 5 carpels, connate with each other and with the hypanthium | Photinia (p. 312) |
| 14a. Evergreen. Ovary 2-celled. Fruits 1-, rarely 2-seeded, seeds thick, cotyledons thick | Rhaphiolepis (p. 317) |
| b. Deciduous. Ovary usually 3-celled (2–4). Fruits with usually 2 seeds per cell, seeds flat, cotyledons flat | Micromeles (p. 310) |

TRIBUS NEILLIEAE

Woody plants with simple leaves. Stipules free, on twig. Epicalyx absent. Usually 1 pistil, superior, enclosed by hypanthium. Ovules 2 or more, mostly pendulous. Follicles. $x = 9$.

NEILLIA

Neillia D. Don, Prod. Fl. Nepal. (Febr. 1825) 228; DC., Prod. 2 (Nov. 1825) 546. — Type species: *Neillia thyrsoflora* D. Don.

Adenilema Blume, Bijdr. (1826) 1120; Hassk., Cat. Hort. Bog. (1844) 170 ('*Adenilemma*'). — Type species: *Adenilema fallax* Blume.

Unarmed shrubs, erect, scandent, or creeping. *Leaves* simple, lobed and dentate. *Stipules* free. *Flowers* in terminal racemes or panicles, 5-merous, bisexual. *Hypanthium* campanulate to tubular, often with stalked glands outside. *Sepals* imbricate, acuminate. *Petals* (sub)orbicular, white. *Stamens* 6–40. *Pistil* 1, rarely 2, free; ovary superior, included in hypanthium, 1-locular; style terminal, with peltate stigma; ovules 2–13, biserially placed on the ventral placenta. *Fruit* a dry follicle, protruding from the enlarged hypanthium. *Seeds* several, with hard and shining testa; endosperm rather plentiful.

Distribution — About 12 species, from the Himalayan region through China to Korea and to Vietnam, one species also in *Malesia*: Sumatra and Java. — **Fig. 1.**

Neillia thyrsoflora D. Don, Prod. Fl. Nepal. (1825) 228; Miq., Fl. Ind. Bat. I, 1 (1855) 391; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 241; Backer & Bakh.f., Fl. Java I (1964) 510; Steenis, Mount. Fl. Java (1972) pl. 44-4. — Types: Wallich 698, Hamilton s.n.

Adenilema fallax Blume, Bijdr. (1826) 1121. — *Neillia fallax* (Blume) Blume, Mém. Bot. I (1855) 6 (see Taxon 35, 1986, 272). — Type: Blume 477, Mt Gede.

Rubus schefferi Focke, Abh. Naturw. Ver. Bremen 8 (1884) 472. — Type: Scheffer s.n., Mt Pan-gerango.

Neillia tunkinensis Vidal, Not. Syst. 13 (1948) 292. — *Neillia thyrsoflora* D. Don var. *tunkinensis* (Vidal) Vidal, Adansonia 3 (1963) 153. — Type: Poilane 26671.

Small shrubs, erect, scandent, or creeping. *Branches* glabrous, ultimate ones often zigzag. *Leaves* ovate, 3-lobed, 4–12 by 2.5–7.5(–11) cm, base cordate to subtruncate, serrate, 3 main nerves, the middle one with 5–7 side-nerves, nerves and veins terminating in marginal teeth, glabrous to sparsely hairy. *Petiole* 0.5–2 cm. *Stipules* membranous, up to 12 by 6.5 mm, \pm serrate. *Inflorescence* a bracteate compound raceme, the lower of

the up to 8 side-branches in the axils of the upper leaves, up to 12(–20) cm long, pedicels up to 2 mm. *Flowers* erect. *Hypanthium* widely campanulate, 1.5–3 mm high, growing after anthesis, hairy to glabrous outside, always with scattered stalked glands, the stalks growing to 6 mm after anthesis. *Sepals* \pm spreading in anthesis, 3–5 by 1–2 mm including the up to 2(–3) mm long acumen, persistent, indumentum outside as hypanthium and often with occasional glands. *Petals* suborbicular to ovate, 1.5–3.5 by 1.5–3 mm, not or shortly clawed, with ciliate margin, early caducous. *Stamens* 7–21, filaments up to 1.2 mm, anthers c. 0.5 mm long. *Pistil* usually 1, ovary ovoid, 1.5–2.5 mm long, style up to 2 mm, ovules 7–10. *Follicle* 6–9 by 2.5–3.5 mm, not including the persistent style remnant. *Seeds* several, up to 2 mm long. — **Fig. 1.**

Notes — *Neillia fallax* has usually been considered as conspecific with *N. thyrsoflora*, but Vidal (1963) separated the two on a specific level mentioning as distinguishing characters: shape of inflorescence, number of stamens and ovules, indumentum on leaves, inflorescences, and pistils. In all but one of these characters, however, there is an unbroken continuity and the only possible way to break up the complex into recognizable and defin-

able sub-units is to make use of the indumentum on raceme axis and pedicels. There is no correlation with other characters and the groups are not geographically separated. In view of this the two groups do not seem worthy of specific rank.

Neillia rubiflora, a continental-Asian species, is very closely related but may remain separated, i.a. because of the larger number of stamens (20–40).

a. var. *fallax* (Blume) Kalkman, *Blumea* 37 (1993) 377. — *Adenilema fallax* Blume, l.c. — *Neillia fallax* (Blume) Blume, l.c. — ? *Rubus schefferi* Focke, l.c.

Inflorescences glabrous, the pedicels sometimes with few short hairs. *Ovary* glabrous or with few long hairs only.

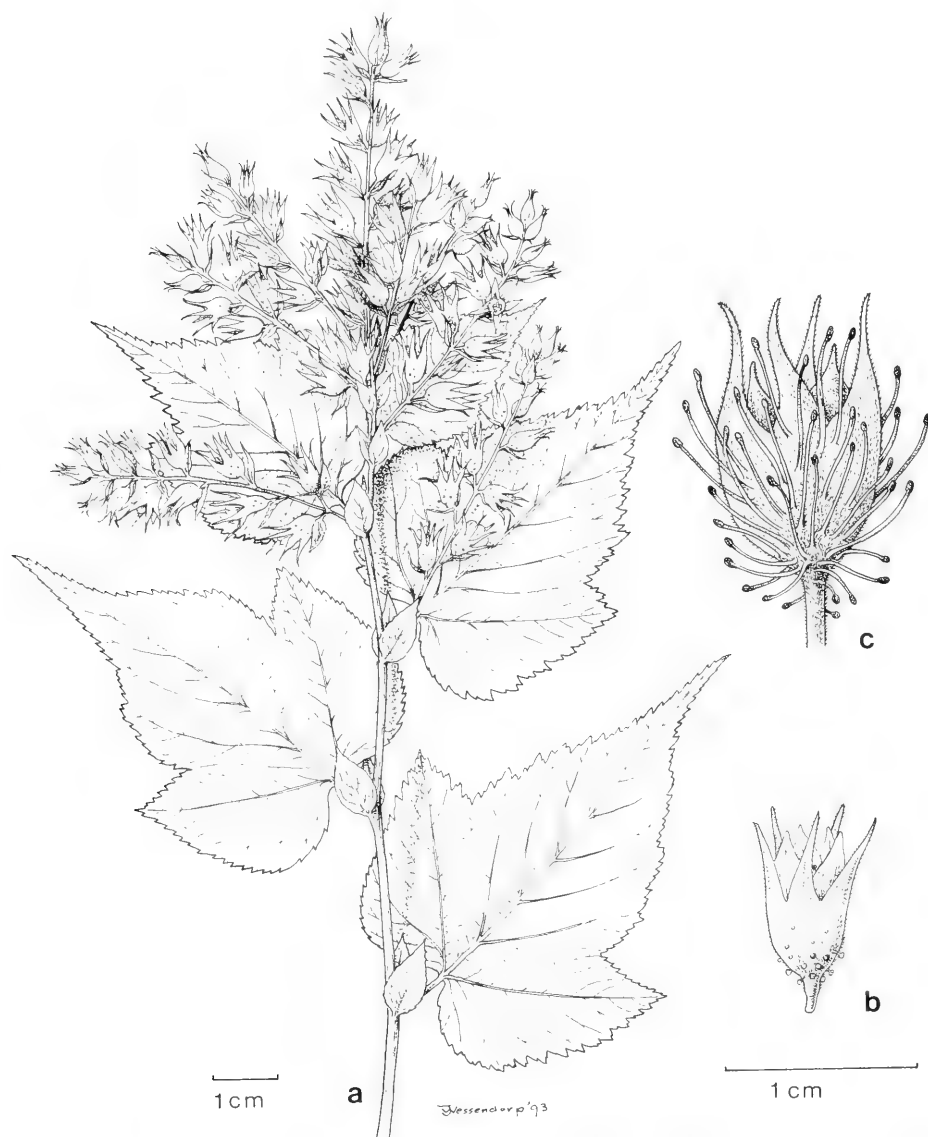


Fig. 1. *Neillia thyrsoflora* D. Don. a. Flowering branch; b. flower; c. hypanthium with fruits (Schiffner 2014).

Distribution — *Malesia*: N & W Sumatra, W Java.

Habitat — Forest margins and similar open places, c. 2100–3000 m altitude.

Note — The Sumatran specimens differ from the Javanese ones in having less hairy leaves and flowers and more stamens (10–21, in Java 7–10).

b. var. *thyrsiflora* — *Neillia tunkinensis* Vidal, l.c.

Inflorescences, incl. pedicels, hairy. *Ovary* long-hairy all over or at least with long hairs near suture and base, rarely (in part of the Sumatra specimens) glabrous.

Distribution — Continental Asia (Himalayan region, Assam, China, Vietnam); in *Malesia*: W Sumatra and W Java.

Habitat — Montane thickets and forest-edges, between c. 1500 and c. 2500 m altitude.

TRIBUS RUBEAE

Woody or herbaceous plants, with simple, pinnate or palmate leaves. Stipules free, on petiole or twig. Epicalyx absent. Petals rarely reduced in number, flowers rarely unisexual. Pistils many, free, superior, on elevated torus. Ovules 2, pendulous. Drupes. $x = 7$. Only genus: *Rubus*.

RUBUS

Rubus L., Sp. Pl. (1753) 492; Focke, Bibl. Bot. 72 (1910–11) 1–223; *ibid.* 83 (1914) 1–274; Zandee & Kalkman, Blumea 27 (1981) 75; Kalkman, Blumea 29 (1984) 319; *ibid.* 32 (1987) 323. — Type species: *Rubus fruticosus* L. See Taxon 41 (1992) 573.

Shrubs (see under Morphology), usually climbing, straggling or creeping, rarely erect, only few species herbaceous. Twigs and other parts nearly always with prickles. Leaves compound (pinnately or palmately structured) or simple, then usually incised. Stipules free, on the base of the petiole or at the junction of twig and petiole, persistent or fugacious, rarely absent. *Inflorescences* terminal, elaborately branched with the lowermost branches often in the axils of the upper leaves, or little or not branched and in axillary bundles, or (rarely) strongly reduced and flowers (sub)solitary. *Flowers* 5-merous, mostly bisexual, rarely unisexual and the plants \pm dioecious. *Sepals* imbricate, often unequal, outer margins often lobed. *Petals* normally longer than sepals, rarely partly or entirely absent, white, less commonly cream-coloured, pink, purplish, or red. *Stamens* many. *Pistils* many, rarely few, free, on a mostly elevated torus; ovaries 1-locular; style terminal, stigma capitate or bifid; ovules 2, only 1 developing. *Fruits* cohering and falling as a collective fruit with or without the torus, or (rarely) coming loose individually, drupes with usually a juicy or fleshy mesocarp and a hard and rugose endocarp. *Seed* with thin testa.

— **Figs. 2–7.**

Distribution — Genus with some hundreds of species, apart from the microspecies in the apogamous *R. fruticosus*/*R. caesius* complex (according to Weber, Phan. Mon. 7, 1972, there are at least 5000 of those in Europe; see also under Taxonomy). Subcosmopolitan. In *Malesia* c. 50 species, New Guinea (17) and the Philippines (c. 17) being richest in species, followed by Java and Sumatra. In the area New Guinea is the only (small) centre of endemism with 12 endemic species, the other islands have very few endemics or none at all.

Habitat — Mainly montane with an altitudinal range between 1000 and 3000 m, about a dozen species normally (also) under 1000 m, only three going down to sea-level, also a dozen species up into the alpine zone above 3000 m. Highest record is 4340 m for *R. archboldianus* (Mt Wilhelm, Papua New Guinea).

Ecology — Most species are light-loving and are restricted to more or less open places, either natural or anthropogenic. There does not seem to be evidence for suspecting apogamy in any of the Malesian species.

Taxonomy — Focke (1910–11) recognized twelve subgenera but made clear in his text (p. 6) that he considered the smaller subgenera to be offshoots from the three larger ones, that represent the main subdivision of the genus: subgenus *Malachobatus* (centred in SE Asia), *Idaeobatus* (centred in E Asia), and *Rubus* (centred in S America). Nevertheless he put the large groups and the small offshoots on the same taxonomical level what from a phylogenetical point of view would not be the most acceptable classification. In the present survey also the subgenus *Micranthobatus* is recognized although it may not be a holophyletic group (see Kalkman, 1987). The subgenus *Chamaebatus* has been maintained with the same misgivings.

The genus *Rubus* has a bad reputation among taxonomists, undeserved since the problems are only caused by one Northern Hemisphere offshoot of the subgenus *Rubus*, the so-called ‘*Moriferi*’ or *R. fruticosus*/*R. caesius* complex. The complex is taxonomically unsolvable, like others of its kind, because of the facultative apogamy and easy hybridization with stable progeny. It is possible to find the same ‘taxa’ year after year, to describe them, and to recognize differences with other, neighbouring ‘taxa’. Over a large area, however, it is impossible to reach a hierarchic classification with more or less equivalent taxa. Although ‘batologists’ admit that their taxa are not comparable, they nevertheless try to classify them in the common scientific classification, and with predictably poor results. As one recent example, H.E. Weber (Die Gattung *Rubus* in NW. Europa, Phan. Monogr. 7, 1972) subdivides the subgenus *Rubus* in three sections (restricted to the NW European species). Of the three sections the *Eufruticosi* is the most important one, the two others accommodate, respectively, the dewberry (*R. caesius*) and the hybrids of the latter with *Eufruticosi* species. In the section *Eufruticosi* one of the two subsections contains the species that some authors consider to be hybrids with *R. idaeus* (belonging to subgenus *Idaeobatus*), the raspberry. The other subsection is divided into eleven series that are poorly recognizable and definable. As Weber himself says, in placing individual species in the series there is much room for the individual discretion of different authors.

The rest of the genus, however, behaves perfectly normally: there is a majority of well-recognizable, clear-cut species, several difficult cases of specific delimitation, and a small number of complexes like *R. moluccanus* that are obviously engaged in active speciation, possibly linked to an enlargement of their habitats by human interference.

Morphology — European blackberry plants (*R. fruticosus* complex) usually make long vegetative shoots, called primocanes or turios, during the summer season. After their first winter a number of shorter mixed shoots appear in the leaf-axils of the primocanes. These mixed shoots, floricanes, are of determinate growth and terminate in an inflorescence. After fruiting, in autumn and winter, the floricanes die back and so does a larger or smaller part of the primocanes. New primocanes will, next spring, appear axillary on the lower

nodes of still living parts of the old primocanes, from the subterranean parts, and from places where overhanging primocanes have rooted. These plants are not really shrubs, therefore. See Weber, l.c. (1972: fig.2).

Part of the tropical *Rubus* species may have the same kind of differentiation and periodicity in the branches but from herbarium specimens reconstruction is impossible. Field observations in the wild and in tropical botanic gardens are needed. In some cases it is obvious from the herbarium that there are two kinds of branches: long and stout ones with large leaves in whose axils shorter branches develop, terminating in an inflorescence. Continuation of growth of these shorter branches, if it occurs, must be sympodial.

Uses — The plants contain tannins, which may be responsible for their use in cases of diarrhoea and throat-troubles. These uses are reported for tea made from leaves of the European *Rubus fruticosus* and also for *R. moluccanus* and some other Malesian species.

The fruits of all species are edible, but not all are as juicy and tasty as the well-known American and European blackberries (*R. fruticosus/caesius* complex), the raspberry (*R. idaeus*), loganberry (*R. × loganobaccus*), or Japanese wine-berry (*R. phoenicolasius*). The fruits of these and other species can be eaten raw as table-fruit or made into preserves, jams, jellies and fruit juices. A few Malesian species could be promising for these purposes, see Kalkman in in E.W.M. Verheij & R.E. Coronel (eds.), *Edible fruits and nuts*, Plant Res. SE Asia (PROSEA Handbook) 2 (1991) 277–278 & 355.

KEY TO THE SPECIES

1a. Leaves simple	2
b. Leaves compound	24
2a. Underside of leaves with a closed felt of thin, curly hairs, apart from straight, stouter hairs on nerves and veins	3
b. Not a closed felt on underside of the leaves, leaf surface visible between the hairs	12
3a. Stipules and bracts entire or with few minute teeth	4
b. Stipules and bracts distinctly toothed to deeply incised	5
4a. Inflorescence richly and widely branched. Sepals at anthesis 5–6 mm long	
	35. <i>R. luzoniensis</i>
b. Inflorescence a compact, few-flowered raceme. Sepals c. 12 mm long	
	39. <i>R. perfulvus</i>
5a. Flowerbuds globular	6
b. Flowerbuds ovoid, pointed	7
6a. Leaves ± ovate, at least 1.4 times as long as wide, not or very shallowly lobed. Dioecious	31. <i>R. elongatus</i>
b. Leaves suborbicular to broadly ovate in outline, ± as long as wide, deeply 5- to 7-lobed. Flowers bisexual	26. <i>R. alceifolius</i>
7a. Inflorescence a simple, compact raceme	41. <i>R. rolfei</i>
b. Inflorescence elaborately branched	8
8a. Leaves bullate above, surface distinctly raised between the veins	9
b. Leaves flat above, nerves (and veins) sometimes slightly impressed but leaf surface between the veins not distinctly raised	11

- 9a. Outer sepals shortly toothed, teeth up to 1.5 mm long. Anthers glabrous
29. *R. chrysophyllus*
- b. Outer sepals with longer lobes or teeth. Anthers hairy on top 10
- 10a. Outer sepals with 5 or more lobes on each side, lobes up to 7 mm long
33. *R. heterosepalus*
- b. Outer sepals with 1–3 teeth on each side, teeth up to 3 mm long **36. *R. malvaceus***
- 11a. Leaves (broadly) ovate, length/width up to 2(–2.5), not or shallowly lobed, if distinctly lobed (var. *angulosus*), the basal lobes overlapping. Stipules early falling, 4–12 mm wide, on each side with 4–10 lobes. Ovaries and fruits glabrous
38. *R. moluccanus*
- b. Leaves broadly ovate, length/width less than 1.5, distinctly 3-lobed, base cordate but lobes not touching. Stipules rather persistent, up to 2 mm wide, with 2 or 3 lobes on each side. Ovaries and fruits glabrous or hairy **34. *R. keleiterios***
- 12a. Creeping plants with solitary, terminal flowers, rarely 1 or 2 axillary flowers under the terminal one. Leaves reniform, often wider than long. Hypanthium and outside of sepals with needle-shaped prickles 13
- b. Erect, climbing, or straggling shrubs with flowers in inflorescences. Leaves usually distinctly longer than wide. Hypanthium and sepals unarmed 14
- 13a. Stipules serrate to dentate **45. *R. calycinus***
- b. Stipules deeply digitately divided **46. *R. pectinellus***
- 14a. Anthers basifixed 15
- b. Anthers dorsifixed or dorso-versatile 16
- 15a. Underside of leaves with scattered hairs only **42. *R. smithii***
- b. Underside of leaves densely hairy **27. *R. beccarii***
- 16a. Ovaries hairy 17
- b. Ovaries glabrous, on hairy or glabrous torus 19
- 17a. Leaves distinctly cordate at base **44. *R. sundaicus***
- b. Leaves with rounded, subtruncate or very shallowly cordate base 18
- 18a. Leaves less than 1.5 times as long as wide, petiole 1.5 cm or longer, nerves terminating in the margin. Flowers unisexual (?) **30. *R. cumingii***
- b. Leaves normally more than 1.5 times as long as wide, petiole rarely longer than 1 cm, nerves not reaching the margin. Flowers bisexual **40. *R. pyrifolius***
- 19a. Petals 5. 20
- b. Petals 0 or 1. 22
- 20a. Leaves suborbicular to broadly ovate in outline, about as long as wide, deeply 5–7-lobed. Stipules and bracts divided into thin thread-like lobes **26. *R. alceifolius***
- b. Leaves longer than wide, not or hardly lobed. Stipules and bracts toothed or dissected but not with thin, thread-like lobes 21
- 21a. Inflorescences laxly paniculate, up to 35 cm long, compound racemes with up to 20 racemes of each up to 30 flowers **28. *R. benguetensis***
- b. Inflorescences rarely longer than 10 cm, racemes of 3- to 1-flowered cymes, the upper ones often congested **32. *R. glomeratus***
- 22a. Flowers large, sepals 10–12 mm long **43. *R. sorsogonensis***
- b. Flowers smaller, sepals 6–8 mm long 23

- 23a. Leaves 1–1.3 times as long as wide. Glandular hairs on outside of hypanthium and sepals, outer sepals on each margin with 3–6 distinct teeth of up to 1 mm long
37. *R. mearnsii*
- b. Leaves 1.4 or more times as long as wide. Outside of hypanthium and sepals without glandular hairs, outer sepals entire or with 1 or 2 minute teeth on each margin
28. *R. benguetensis*
- 24a. Leaves pinnate with more than 3 leaflets, or bipinnate 25
- b. Leaves 3-foliolate or pedately/palmately 5-foliolate. 32
- 25a. Needle-shaped spines on stems, leaves and also on hypanthium 1 to 5 spines alternating with the sepals 26
- b. Prickles not needle-shaped 28
- 26a. Leaves bipinnate, 3-pinnate at base, simply pinnate at apex
20. *R. montis-wilhelmi*
- b. Leaves simply pinnate 27
- 27a. Leaflets 1–4 by 0.5–2 cm, with 7–12(–18) teeth on each side, upper surface glabrous or hairy between the nerves, lower surface glabrous or hairy on midrib and veins **14. *R. ferdinandi-muelleri***
- b. Leaflets 0.5–1.5 by 0.5–1 cm, with 4–6(–7) teeth on each side, both surfaces glabrous or almost so **23. *R. papuanus***
- 28a. Stems and leaves with up to 5 mm long gland-tipped hairs **25. *R. sumatranus***
- b. No long gland-tipped hairs present 29
- 29a. Leaves almost glabrous 30
- b. Leaves hairy, at least on underside. 31
- 30a. Leaflets biserrate, with long-tapering apex. Pistils down to the base of the torus, ovaries with shortly stalked glands **11. *R. chrysogaeus***
- b. Leaflets serrate, apex acute to long-pointed. Base of torus without pistils. Ovaries without glands **15. *R. fraxinifolius***
- 31a. Leaflets below with a dense, woolly, silvery-white felt all over and with straight hairs on the nerves. Flowers small: sepals 4–7 mm long, petals 3.5–5 mm long, pink. Ovaries and fruits densely hairy **22. *R. niveus***
- b. Leaflets below long-hairy but without woolly felt. Flowers large: sepals 7–15 mm or longer, petals 8–17 mm long, white. Ovaries with stalked glands and apically with some hairs **24. *R. rosifolius***
- 32a. Leaves 5-foliolate, the uppermost ones and/or the first leaves on a branch sometimes only 3-foliolate 33
- b. Leaves 3-foliolate, the upper ones sometimes unifoliolate 37
- 33a. Leaflets with 18 or (many) more pairs of nerves. Unarmed or prickles very rare 34
- b. Leaflets with 6–17 pairs of nerves. Armed 35
- 34a. Normally 30–40 pairs of nerves. Stipules 2–4 cm long. Sepals sericeous outside, the covered parts woolly. Petals 4–5 mm long, distinctly shorter than sepals
16. *R. lineatus*
- b. Normally 16–26 pairs of nerves. Stipules 0.5–1 cm long. Sepals with few hairs outside, covered parts woolly. Petals 9–12 mm long, \pm as long as sepals
21. *R. neo-ebudicus*

- 35a. Prickles rather few. Stipules long persistent, 4–12 mm long. Inflorescences monochasial or dichasial **8. *R. alpestris***
- b. Prickles rather many. Stipules absent or fugacious, 3–7 mm long. Inflorescences racemose, racemes solitary or in bundles 36
- 36a. Terminal leaflets 4.5–12 by 2–7 cm, with 9–14 pairs of nerves. Racemes with 10–25 flowers, solitary or in bundles. Filaments glabrous. Ovaries glabrous or hairy, not glandular **5. *R. royenii***
- b. Terminal leaflets 3–5 by 2–3 cm, with 6–8 pairs of nerves. Racemes with 2–7 flowers, solitary. Filaments long-hairy. Ovaries hairy and dorsally with many yellow glands **4. *R. novoguineensis***
- 37a. Stems unarmed or almost so 38
- b. Stems armed 40
- 38a. Leaflets with more than 16 pairs of nerves **21. *R. neo-ebudicus***
- b. Leaflets with fewer than 10 pairs of nerves 39
- 39a. Inflorescence a large, terminal thyse with up to 20 rich-flowered laterals under the terminal flower **1. *R. clementis***
- b. Inflorescence much poorer, with under the terminal flower only 1–4 axillary cymes of up to 4 flowers **18. *R. lowii***
- 40a. Hypanthium outside with up to 5 mm long bristles or spine-like hairs, otherwise hairy or not 41
- b. Hypanthium outside without bristles or spines, with or without short hairs and/or few short prickles 44
- 41a. Stipules deeply divided. Petals red. Ovaries hairy **9. *R. archboldianus***
- b. Stipules entire, serrate, or with some short teeth. Petals white 42
- 42a. Hypanthium outside with straight prickles and with capitate spines, otherwise glabrous. Ovaries glabrous. Fruits red **12. *R. copelandii***
- b. Hypanthium outside hairy and with straight bristles 43
- 43a. Stipules 10–18 by 3–15 mm. Inflorescences poor, usually less than 8 flowers. Ovaries glabrous. Fruits orange to red **17. *R. lorentzianus***
- b. Stipules up to 10 by 0.5 mm. Inflorescences rich, up to 150 flowers or more. Ovaries hairy. Fruits yellow to orange **13. *R. ellipticus***
- 44a. Flowers solitary and terminal or in poor racemes of 2–5 flowers. 45
- b. Inflorescences richer, thyrsoid or racemose 47
- 45a. Underside of leaflets woolly all over **3. *R. megacarpus***
- b. Underside of leaflets glabrous or with hairs on midrib and larger nerves only . . 47
- 46a. Ovaries long-hairy **19. *R. macgregorii***
- b. Ovaries glabrous **18. *R. lowii***
- 47a. Under the terminal flower up to 6 lateral cymes or dichasia in the axils of bracts or leaves. Flowers bisexual 48
- b. Axillary racemes, almost always simple, rarely partly with cymes instead of flowers, racemes solitary or in bundles of up to 4. Flowers (always?) unisexual 50
- 48a. Stipules deeply divided **10. *R. banghamii***
- b. Stipules entire or with 1 or 2 small teeth 49

- 49a. Petals longer than sepals, early falling. Stamens and pistils both more than 150
7. *R. acuminatissimus*
- b. Petals shorter than sepals, long-persistent. Stamens up to 45, pistils up to 25
18. *R. lowii*
- 50a. Terminal leaflets 3–10 by 2–7 cm. Flowers small: sepals 2.5–4 mm, petals 4–8 mm long **2. *R. diclinis***
- b. Terminal leaflets 10–15 by 8–12 cm. Flowers larger: sepals 6–7 mm, petals 10–17 mm long **6. *R. trigonus***

Subgenus *Micranthobatus*

Rubus subg. *Micranthobatus* (Fritsch) Kalkman, Blumea 32 (1987) 324. — *Rubus* sect. *Micranthobatus* Fritsch, Österr. Bot. Zeitschr. 36 (1886) 259.

Leaves palmate, rarely unifoliolate. *Leaflets* pinninerved, nerves terminating in the margin. *Stipules* absent or 1 or 2 on the base of the petiole. *Inflorescences* terminal thyrses or axillary bundles of (1–)2–5 racemes. *Flowers* uni- or bisexual. *Hypanthium* saucer-shaped, sometimes with prickles outside. *Sepals* (sub)equal, entire. *Fruits* falling as a coherent collective from the torus, rarely falling separately (?).

Distribution — Twelve species with an East Gondwanan type area: Australia, New Guinea, New Zealand, Celebes, Borneo, Philippines, NE India, Madagascar. In *Malesia* 6 species.

1. *Rubus clementis* Merr., Philipp. J. Sc., Bot. 3 (1908) 139; Elmer, Leafl. Philipp. Bot. 2 (1908) 458. — *Rubus lucens* Focke var. *clementis* (Merr.) Focke, Bibl. Bot. 72 (1911) 213; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 228. — Type: *Clemens* 740, Mindanao.

Climbing or scrambling shrubs. *Stems* up to 20 m long, unarmed or with few, short, curved prickles, short-hairy and with minute, stalked glands. *Leaves* 3-foliolate, petiole 5–9 cm long. *Stipules* on the petiole, up to 5 mm above its base, linear, up to 7 by 1 mm, rather persistent. *Leaflets* ovate to elliptic, terminal ones 8–13.5 by 4.5–9 cm, lateral ones usually slightly smaller, base rounded, margin shallowly serrate in upper part, apex acuminate, nervation pinnate with 7–9 pairs of nerves, often near the end with one strong acropetalous tertiary vein, venation transverse, sparsely short-hairy and with minute glands. *Inflorescence* terminal, up to 55 cm long, a hanging thyrses with up to 20 laterals in the axils of bracts or leaves, the lower laterals up to 25 cm long. *Bracts* linear, up to 5 mm long. *Pedicels* up to 5 mm long, growing to 10 mm, densely short-hairy

as are the rachises. *Flowers* uni- or bisexual, plants probably polygamo-dioecious. *Hypanthium* saucer-shaped, 3.5–5 mm across, woolly outside. *Sepals* triangular to ovate, 3.5–5 by 3–4.5 mm, obtuse, apiculate to acuminate, densely short-woolly outside. *Petals* obovate to elliptic, 5.5–9 by 4–6 mm, white. *Stamens* 70–160, filaments up to 2.5 mm, anthers 1–1.5 mm long, staminodes in female flowers 1–2 mm, including minute anther rudiment. *Pistils* 30–70, ovaries glabrous or with long hairs dorsally near apex, on elevated, hairy torus, style 2–3 mm long, sometimes hairs at base, pistillodes in male flowers 2 mm including style. *Collective fruits* globular, 1–1.5 cm, sepals closing and enlarging after anthesis. *Fruits* densely packed, 2.5–3.5 mm by 1.5–2 mm when dry, exocarp sometimes still hairy, red to orange-red, mesocarp juicy.

Distribution — Northern part of Sumatra, Borneo, Mindanao, Celebes.

Habitat — In forest along rivers and brooks, also in open places in forest and shrubland, altitude 150–1300(–1800) m.

Note — The disposition of uni- and bisexual flowers is incompletely known, see Kalkman (1987).

2. *Rubus diclinis* F. Muell., Trans. Roy. Soc. Vict. 1 (1889) 5; P. van Royen, Phan. Mon. 2 (1969) 69, only var. *diclinis*; Alpine Fl. New Guinea 4 (1983) 2481, idem. — Types: *MacGregor s.n.*, Mt Knutsford, Mt Musgrave.

Rubus tsiri P. van Royen, Phan. Mon. 2 (1969) 77, excl. most specimens cited; Alpine Fl. New Guinea 4 (1983) 2486, idem. — *Rubus paradoxus* Ridley, Trans. Linn. Soc. Lond. II, Bot. 9 (1916) 36, nom. illeg., non S. Moore (1878). — Types: *Kloss* specimens, Mt Jaya (Carstensz).

Climbing or scrambling shrubs. *Stems* up to 5(–18?) m long, densely patently hairy, sometimes with shortly stalked glands, prickles rather many, curved, small. *Leaves* 3-foliolate, petiole 1.5–5.5 cm long. *Stipules* very rarely present, on the petiole, up to 4 by 0.5 mm. *Leaflets* elliptic to ovate, terminal ones 3–10 by 2–7 cm, lateral ones smaller, base rounded to shallowly cordate, margin serrate, apex acute, hard-chartaceous, nervation pinnate with (6)–8–12 pairs of nerves, venation transverse, scattered hairy above, sparsely to densely golden to brownish hairy below. *Inflorescences* simple racemes, solitary or in bundles of up to 4 in the leaf axils, up to 8 cm long, peduncle 0–2 mm, some empty bracts at base, up to 15 flowers. *Bracts* up to 7 by 4 mm. *Pedicels* 4–10 mm long, densely hairy and always with small curved prickles, as is the rachis. *Flowers* normally unisexual, sometimes bisexual (at least appearing so in the herbarium). *Hypanthium* saucer-shaped, 2.5–3 mm across, woolly and with patent hairs outside. *Sepals* elliptic to tongue-shaped, 2.5–4 by 1.5–3.5 mm, with straight hairs outside and woolly on the margins, pinkish or purplish inside. *Petals* elliptic to oblong, 4–8 by (1)–2.5–4.5 mm, obtuse or emarginate, patently hairy inside, white or pale pink. *Stamens* 18–40, filaments up to 4.5 mm, anthers 0.5–1 mm long, staminodes in female flowers small and ± petaloid. *Pistils* 10–20, ovaries hairy or glabrous, on elevated, densely hairy torus, style up to 1.5 mm long, pistillodes in male flowers minute. *Collective fruits* up to 1.5 cm when living, 1 cm when dry, sepals spreading. *Fruits* well separated, up to 5(–7) by 4 mm when dry, exocarp hairy or glabrous, dark red to black, mesocarp rather thick and fleshy when living, rather thin when dry.

Distribution — New Guinea.

Habitat — Montane forest, clearings, forest edges, secondary forest, shrubland, altitude 1750–3470 m, rarely lower.

Uses — On one herbarium label the leaves are reported to be used "in smoking", i.e. as cigarette wrapper.

3. *Rubus megacarpus* P. van Royen, Phan. Mon. 2 (1969) 65; Alpine Fl. New Guinea 4 (1983) 2480. — Type: *Brass* 30099, Mt Wilhelm.

Climbing or scrambling shrubs. *Stems* up to 10 m long, densely hairy, prickles many, short, curved, some cataphylls at base of lateral shoots. *Leaves* 3-foliolate, petiole 1.5–5 cm long. *Stipules* not always present, on the petiole, filiform to linear, 4–6 by 0.1–0.5 mm, early falling. *Leaflets* obovate to elliptic, 3–6 by 2–3 cm, lateral ones usually relatively narrower than apical one, shallowly serrate in upper part only, apex rounded to truncate, with or without apiculus, stiff-coriaceous, nervation pinnate with 5–7 pairs of steeply ascending nerves, venation transverse, glabrous above, lower surface densely woolly all over and with appressed straight hairs on midrib and nerves. *Inflorescence* a simple raceme, axillary, up to 12 cm long, rachis stiff, with up to 5 flowers, often reduced to only the terminal flower. *Bracts* 5–9 by 1.5–3 mm, persistent, also empty ones under the flowers. *Pedicels* up to 4 cm long, densely hairy as is rachis. *Flowers* uni- or bisexual. *Hypanthium* saucer-shaped, 6–10 mm across, densely hairy outside. *Sepals* broadly ovate, 9–12 by 8–11 mm, inner ones slightly narrower than outer ones, obtuse and apiculate, shortly woolly and with appressed hairs outside, pale purplish. *Petals* obovate, 13–20 by 8–13 mm, densely long-hairy in basal half outside, (pinkish or greenish) white. *Stamens* 70–100, filaments up to 10 mm, with long hairs, anthers up to 2 mm long, staminodes in female flowers minute. *Pistils* c. 150, ovaries densely hairy, on high, densely hairy torus, style up to 3 mm long, pistillodes in male flowers minute. *Collective fruits* large, up to 5.5 by 4 cm when living, most of the pistils developing, sepals appressed to spreading after anthesis. *Fruits* closely packed, up to 9 by 7 mm when dry, exocarp densely whitish-hairy, purplish, mesocarp still thick when dry, stone up to 8 by 6 mm. — **Fig. 2.**

Distribution — New Guinea, only known from Mt Wilhelm.

Habitat — Alpine shrubland and mossy forest, altitude 3500–3750 m.

4. *Rubus novoguineensis* Merr. & Perry, J. Arnold Arbor. 21 (1940) 183; Kalkman, Blumea 32 (1987) 337. — *Rubus diclinis* F. Muell. var. *novoguineensis* (Merr. & Perry) P. van Royen, Phan. Mon. 2 (1969) 75; Alpine Fl. New Guinea 4 (1983) 2484. — Type: *Brass* 4337, Mt Albert Edward.



Fig. 2. *Rubus megacarpus* P. van Royen. Fruiting twig (Brass 30099). Photo P. van Royen.

Scrambling or trailing shrubs. *Stems* up to 2 m long, densely hairy and with few stalked glands, glabrescent, prickles rather many, curved, up to 2 mm, several cataphylls at base of laterals. *Leaves* palmately 5-foliolate, the first leaves on a branch sometimes 4- or 3-foliolate, petiole 2.5–5.5 cm long, petioles and petiolules hairy, with rather many strongly curved prickles. *Stipules* maybe not always present, on the petiole, 3–5 by less than 1 mm, hairy. *Leaflets* elliptic, terminal ones 3–5 by 2–3 cm, base rounded to slightly cordate, margin serrate, apex rounded, chartaceous, nervation pinnate with 6–8 pairs of nerves, venation transverse, densely (semi-)patently hairy below, glabrescent. *Inflorescence* a simple raceme, axillary, 5–7.5 cm long, with 2–7 flowers, peduncle up to 2 cm, with some to many prickles. *Bracts* up to 6 by 2 mm, also empty ones at base of peduncle. *Pedicels* 1.5–4 cm long, with prickles. *Flowers* unisexual and plants dioecious or polygamodioecious.

Hypanthium flat, 3–3.5 mm across, appressed-hairy and glandular outside, sometimes with a prickle. *Sepals* elliptic, 3.5–7 by 3–6 mm, obtuse, indumentum outside as hypanthium, purplish. *Petals* elliptic, 5–7 by 3.5–7 mm, rounded to slightly emarginate at apex, hairy, pale green to white. *Stamens* 14–20, filaments up to 2.5 mm, long-hairy, anthers c. 1 mm long, staminodes in female flowers minute. *Pistils* 17–25 in a compact globe, ovaries densely long-hairy and yellow-glandular on the backside, on a flat hairy torus, style 0.8–1 mm long. *Collective fruits* globular, 1–1.5 cm when dry, up to 2.5 cm when living, sepals spreading. *Fruits* well separated, 5–7 by 4–4.5 mm, exocarp hairy and dorsally also glandular, brown (?), mesocarp thick.

Distribution – New Guinea, only known from Central Prov. in Papua New Guinea.

Habitat – Open places in forest and in forest margins, altitude 2800–3680 m.

Note – Closely related is the Australian *Rubus moorei* F. Muell., under which name two species are hiding. See Kalkman, l.c.: 334, 338.

5. *Rubus royenii* Kalkman, Blumea 32 (1987) 333. — *Rubus tsiri* auct. non P. van Royen: P. van Royen, Phan. Mon. 2 (1969) 77, excl. type; Alpine Fl. New Guinea 4 (1983) 2486, excl. type. — Type: *Brass 30919*, Mt Otto.

Rubus diclinis F. Muell. var. *ikilimbu* P. van Royen, Phan. Mon. 2 (1969) 75; Alpine Fl. New Guinea 4 (1983) 2486. — *Rubus royenii* Kalkman var. *ikilimbu* (P. van Royen) Kalkman, l.c.: 336. — Type: see below.

Rubus moorei auct. non F. Muell.: Merr. & Perry, J. Arnold Arbor. 21 (1940) 184, in obs.

Climbing, scrambling, or trailing shrubs. *Stems* up to 6(–10) m long, variously hairy, prickles rather many, 1–2 mm long, straight to slightly curved, shoots with large cataphylls at base. *Leaves* palmately 5-foliolate, occasionally 4- or 3-foliolate, petiole 3–11 cm long, with many small, curved prickles. *Stipules* usually absent. *Leaflets* elliptic to ± ovate, terminal ones 4.5–12 by 2–7 cm, shallowly cordate to rounded at base, margin dentate-serrate, apex acute to acuminate, chartaceous, nervation pinnate with 9–14 pairs of nerves, rather often forking, venation transverse, indumentum various. *Inflorescences* simple racemes, 1–5 in the leaf axils, 6–15 cm long, peduncle 0–1 cm, with up to 25 flowers. *Bracts* 3–7 by 1–4 mm, also empty ones at base of peduncle. *Pedicels* 4–18 mm long, densely hairy and with small prickles, as is rachis. *Flowers* unisexual, plants probably dioecious. *Hypanthium* saucer-shaped, densely hairy outside, sometimes with prickles. *Sepals* ± elliptic, obtuse, densely hairy outside on the marginal parts, pinkish. *Petals* elliptic, obtuse to emarginate, long-hairy inside, white to pink. *Stamens* glabrous, staminodes in female flowers minute. *Ovaries* glabrous or with long hairs in upper part, on (slightly) elevated, hairy torus, pistillodes in male flowers minute. *Collective fruits* globular, up to 2 cm, probably late in attaining their final dimensions, sepals spreading. *Fruits* dark red to black, with thick mesocarp.

Distribution – New Guinea, New Britain.

Habitat – Open places and forest, up to 3400 m altitude, rarely collected below 1200 m.

Note – Related is the Australian *Rubus moorei* F. Muell., under which name two species are hiding. See Kalkman, l.c.: 334, 338.

KEY TO THE VARIETIES

- 1a. Long, non-glandular bristles of 3–4(–5) mm long on stems, petioles and petiolules
 - a. var. **hispidus**
- b. Bristles absent 2
- 2a. Stalked glands absent. Leaves glabrous to sparsely hairy on both sides. Flowers small: sepals 3–4 mm, petals 5–7.5 mm long, stamens 20–40, pistils 10–30
 - c. var. **royenii**
- b. Stalked glands on stems, petioles, inflorescences, and pedicels. Leaves hairy on upper surface, densely so on midrib and large nerves, lower surface densely soft-hairy on all nerves and veins. Flowers larger: sepals 3.5–5 mm, petals 8–10 mm long, stamens 45–60, pistils c. 50 b. var. **ikilimbu**

a. var. *hispidus* Kalkman, Blumea 32 (1987) 336. — Type: *Sayers & Millar NGF 19884*, Mt Wilhelm.

Stems with many, reddish to brown, 3–4(–5) mm long, straight, non-glandular bristles, otherwise sparsely hairy to glabrous. *Stipules* rarely present, on the petiole, linear, 3–7 mm long. *Petioles* and *petiolules* densely hairy and with bristles. *Leaflets* on upper surface glabrous, lower surface sparsely short-hairy on main nerves and sometimes minutely glandular. *Hypanthium* 1.5–2.5 mm across. *Sepals* 2–3 by 1.8–3 mm. *Petals* 4.5–6.5 by 2–3 mm, white. *Stamens* 14–20, filaments up to 1.5 mm. *Pistils* 10–20. *Collective fruit* up to 1.5 cm (living), fruits growing to 6 by 4.5 mm.

Distribution – Papua New Guinea, New Britain.

Habitat – Forest, forest edges, disturbed places, shrubland, altitude (1800–)2400–3400 m.

Note – One chromosome count $2n = 28$ was made by Borgmann, Zeitschr. f. Bot. 52 (1964) 124, as *Rubus spec.*, with *Borgmann 203* as voucher.

b. var. *ikilimbu* (P. van Royen) Kalkman, Blumea 32 (1987) 336. — *Rubus diclinis* F. Muell. var. *ikilimbu* P. van Royen, Phan. Mon. 2 (1969) 75. — Type: *Hoogland & Pullen 6179*, Upper Wahgi Valley.

Stems, petioles, and petiolules densely soft-hairy and often with stalked glands, their stalks up to 1(–2.5) mm long. *Leaflets* on upper surface hairy all over, densely so on main nerves, ± glabrescent, on lower surface densely patently soft-hairy on all nerves and veins. *Inflorescence* rachis and pedicels with stalked glands. *Hypanthium* 3.5–

4.5 mm across, sometimes with stalked glands outside. *Sepals* 3.5–5 by 2.5–3.5(–5) mm. *Petals* 8–10 by 4–5 mm, pink. *Stamens* 45–60, filaments up to 2.5 mm. *Pistils* c. 50. *Collective fruit* up to 2 cm (dry), fruits up to 8 by 5.5 mm (dry).

Distribution — Papua New Guinea.

Habitat — Secondary forest and shrubland, altitude 1280–2560 m.

Uses — Stems used for making ropes, leaves are smoked (Note on Flenley ANU 2071 from Wabag).

c. var. *royenii*

Stems, petioles, and petiolules sparsely hairy to glabrous. *Leaflets* on both surfaces sparsely hairy on nerves to glabrous. *Hypanthium* 2.5–3 mm across. *Sepals* 3–4 by 2.5–3 mm. *Petals* 5–7.5 by 2.5–3.5 mm, (pinkish- or cream-)white. *Stamens* 20–40, filaments c. 2.5 mm. *Pistils* 10–30. *Collective fruit* c. 7 mm, fruits up to 4 by 3.5 mm when dry.

Distribution — New Guinea.

Habitat — Forest margins, secondary forest and shrubland, streambanks; alt. (670–)1900–3340 m.

6. *Rubus trigonus* Kalkman, *Blumea* 37 (1993) 378. — *Rubus cordiformis* Kalkman, *Blumea* 32 (1987) 331, non Weber & Martensen, *Sonderb. Naturwiss. Ver. Hamburg* 4 (1981) 100. — Type: *Brass* 30932, Mt Wilhelm.

Climbing or scrambling shrubs. *Stems* up to 6 m long, densely patently hairy and with small, subsessile glands, prickles rather many, 1–1.5 mm long, large cataphylls at base of shoots. *Leaves* 3-foliolate, petiole 5–12 cm long. *Stipules* not seen. *Leaflets* ovate, terminal ones 10–15 by 8–12 cm,

lateral ones slightly smaller, basal part usually folded back in herbarium, base cordate, margins irregularly dentate, apex acuminate, nervation pinnate (pedate) with 6–9 pairs of nerves, the lowermost with some strong basiscopic side-nerves, venation transverse, patently hairy, nerves on underside with glands. *Inflorescence* very lax, usually a simple raceme, sometimes partly branched from the bracteoles, up to 20 cm long, peduncle 0–2 mm long, racemes solitary or 2 or 3 in the axils of leaves or cataphylls, with up to 10 flowers. *Bracts* 4–10 mm long. *Pedicels* 2–5.5 cm long, densely hairy as is the rachis. *Flowers* unisexual, plants probably dioecious. *Hypanthium* saucer-shaped, 4–5 mm across, densely hairy outside. *Sepals* elliptic, 6–7 by 4–7 mm, obtuse, with patent hairs and glands outside, the marginal parts woolly. *Petals* elliptic, 10–17 by 4–10 mm, long-hairy at base inside, white or cream-coloured. *Stamens* 40–60, filaments up to 7 mm, anthers 1–1.5 mm long, staminodes in female flowers minute. *Pistils* c. 60, ovaries densely hairy, on slightly elevated, hairy torus, style 1 mm long, pistillodes in male flowers c. 30, minute to small. *Collective fruits* ellipsoid, c. 1.2 by 1 cm, sepals spreading under the ripe fruits. *Fruits* 4 by 3 mm when dry, exocarp and mesocarp forming a thin layer when dry, hairy in upper part, colour unknown.

Distribution — New Guinea (only known from Papua New Guinea).

Habitat — Shrubland and forest (margins), altitude 1500–3200 m.

Notes — Dr. A. A. van de Beek drew my attention to the older homonym.

See also under Dubious names, *Rubus declinis* F. Muell. var. *papuanus* Focke.

Subgenus *Ideobatus*

Rubus subg. *Idaeobatus* (Focke) Focke, *Bibl. Bot.* 72 (1911) 128; Zandee & Kalkman, *Blumea* 27 (1981) 79–113. — *Rubus* sect. *Idaeobatus* Focke, *Abh. Naturw. Ver. Bremen* 4 (1874) 147.

Leaves 3-foliolate, palmately 5-foliolate, or imparipinnate, rarely bipinnate, rarely 1-foliolate (not in Malesia). *Leaflets* pinninerved, nerves terminating in the margin. *Stipules* on the basis of the petiole, persistent. *Inflorescences* thyrsoid, ± elaborate, terminal or sometimes also lateral. *Flowers* bisexual. *Hypanthium* saucer-shaped. *Sepals* (sub)equal, usually entire. *Fruits* cohering, becoming loose from the torus as a whole, endocarp rugose.

Distribution — Many species, distributional centre in Asia, extending to Australia and the Pacific islands, Africa including Madagascar, islands in the Indian Ocean, few in N and C America, one species (*R. idaeus*) in Europe. In Malesia 19 species.

7. *Rubus acuminatissimus* Hassk., Tijds. Nat. Gesch. Phys. 10 (1843) 146, excl. syn. *Rubus moluccus parvifolius* Rumph.; Miq., Fl. Ind. Bat. I, 1 (1855) 377; Backer & Bakh. f., Fl. Java 1 (1964) 514. — Type: probably a living plant in the Bot. Gard. Buitenzorg (Bogor), not maintained in herbarium.

Rubus podocarpus Kuntze, Rev. Gen. Pl. 1 (1891) 223. — Type: Kuntze 5350, Java.

Climbing shrubs, sometimes erect? *Stems* up to 3 m long, glabrous, prickles rather many, curved, stout. *Leaves* 3-foliolate, usually 1-foliolate near and in the inflorescence, petiole 1.5–5 cm long. *Stipules* linear, 3–7 by up to 1 mm, with some long hairs. *Leaflets* elliptic to oblong or ovate-oblong, terminal one 4–11 by 2–6 cm, lateral ones 2–9 by 1–4 cm, base rounded, margin serrate, apex acuminate, thinly herbaceous, 6–13 pairs of nerves, upper surface with patent hairs on main nerves, sometimes appressed hairs between them, lower surface glabrous except some hairs on larger nerves. *Inflorescence* lax, up to 5 cymes below the terminal flower, the cymes 1- to 3-flowered. *Bracts* often leaf-like or 3-partite. *Pedicels* up to 5 cm long, glabrous, with prickles. *Hypanthium* 5–6 mm across, glabrous outside, unarmed or with few short prickles. *Sepals* triangular to narrowly ovate, 6–12 by 3–6 mm, growing to 17 mm after anthesis, pointed, entire, glabrous outside but woolly on the covered margins, thick and hard. *Petals* obovate, 12–15 by c. 8 mm, falling early, emarginate, with ciliate undulate margin, white. *Stamens* 150–180, filaments up to 5 mm, anthers c. 1 mm long. *Pistils* more than 150, ovaries glabrous, on elevated, glabrous torus, the lower part without pistils and stalk-like, style up to 2.5 mm. *Collective fruits* (depressed) globose, up to 1.5 cm, sepals ultimately recurved. *Fruits* c. 2 by 1 mm (dry), exocarp orange-red to red, mesocarp a thin membranous layer when dry.

Distribution – Sumatra, W Java.

Habitat – Forest edges and lighter places in forest, altitude 1450–2200 m, descending to 700 m along watercourses [Backer & Bakh. f., Fl. Java 1 (1964) 514].

8. *Rubus alpestris* Blume, Bijdr. (1826) 1108; Miq., Fl. Ind. Bat. I, 1 (1855) 378; Backer & Bakh. f., Fl. Java 1 (1964) 514; Steenis, Mount. Fl. Java (1972) pl. 45-1; Naruhashi & Sato, Tukar-Menukar 2 (1983) 11. — Type: Blume 407, Java.

Climbing or erect shrubs, up to 4 m. *Stems* sparsely hairy when young, with many to few

short glandular hairs, prickles rather few, up to 7 mm, curved to straight. *Leaves* palmately (sometimes ± pedately) 5-foliolate, upper ones often 3-foliolate, petiole (1–)2–5 cm long. *Stipules* linear to linear-lanceolate, 4–12 by 0.5–2 mm (larger and wider in Celebes and Moluccas), entire or with some small teeth, with some glandular hairs, otherwise ± glabrous. *Leaflets* oblong, rarely obovate-oblong, terminal ones (4–)6–14 by 2–4 cm, lateral ones smaller, base acute, margin serrate to biserrate, apex acuminate to caudate, papery to pergamentaceous, 9–17 pairs of nerves, upper surface with few hairs, lower surface hairy. *Inflorescences* in the axils of the upper 1–3 leaves, apex of flowering twig usually (?) aborted, dichasial with 1–6 flowers, peduncle up to 5 cm. *Bracts* elliptic to lanceolate, up to 12 mm long. *Pedicels* up to 3 cm long, sparsely pubescent and with glandular hairs. *Hypanthium* 6–8 mm across, glabrous to sparsely hairy outside. *Sepals* ovate-triangular to narrowly triangular, 10–15(–17) by 2.5–6 mm, entire or outer ones with 1–2 marginal teeth, acuminate to long-caudate, acumen up to 6 mm, few hairs outside but covered margins shortly woolly. *Petals* orbicular to elliptic, 6–7 by 5–6 mm, falling early, with few hairs inside, light green to white or pink. *Stamens* c. 50–60, filaments up to 4 mm, anthers 1–1.5 mm long. *Pistils* 15–25, ovaries glabrous, on little elevated to flat, hairy torus, style up to 8 mm long. *Collective fruits* ovoid, c. 1 cm, sepals upright. *Fruits* up to 4 by 2.5 mm (dry), red, mesocarp moderately thin when dry.

Distribution – N Thailand, N Vietnam; *Malesia*: Sumatra, Borneo, Java, Celebes, Moluccas.

Habitat – Lighter places in forest and shrubland, altitude 1650–2850(–3000) m.

Uses – Fruits edible, the species even recommended for planting by Koorders (on Koorders 31658).

9. *Rubus archboldianus* Merr. & Perry, J. Arnold Arbor. 21 (1940) 180; P. van Royen, Phan. Mon. 2 (1969) 57; Alpine Fl. New Guinea 4 (1983) 2477. — Type: Brass 4565, Whar-ton Range.

Climbing or scrambling shrubs. *Stems* up to 5 m, with long hairs, glabrate, prickles up to 2 mm, curved, often purplish. *Leaves* 3-foliolate, upper ones sometimes simple, petiole 1–4 cm long. *Stipules* deeply divided into up to 6 linear lobes, 4–15 mm long, hairy outside. *Leaflets* elliptic, ovate-elliptic, or obovate-elliptic, sometimes deltoid or rhomboid, terminal ones 1.5–12 by 2–6.5

cm, lateral ones up to 5.5 by 4 cm, base usually acute, margin serrate, apex obtuse to acute or acuminate, coriaceous, 5–10(–12) pairs of nerves, upper surface more or less densely long-hairy, lower surface with hairs mainly on the nerves. *Inflorescences* with 1 or 2 cymes under the terminal flower, the cymes 1- or 2-flowered. *Bracts* stipule-like. *Pedicels* up to 4 cm long, hairy and with some prickles. *Hypanthium* up to 15 mm across, long-hairy and with many straight prickles outside, prickles up to 5 mm. *Sepals* ovate to triangular, 12–18 by 6–10 mm, growing after anthesis, caudate, exposed margins with up to 15 long and slender teeth, indumentum outside as hypanthium, purplish or reddish. *Petals* obovate or spatulate, distinctly clawed, 11–18 by 7–10 mm, early falling, (orange or pinkish) red. *Stamens* 50–75, filaments up to 10 mm, anthers up to 1.5 mm long. *Pistils* 35–90, ovaries long-hairy in upper part, on elevated, glabrous torus, style up to 7 mm long, hairy at base. *Collective fruits* depressed ovoid, up to 3 cm. *Fruits* 4–5 by 2–2.5 mm, exocarp long-hairy and with a silky shine, dark red, mesocarp juicy, endocarp dorsally keeled.

Distribution — New Guinea, only known from the Eastern part.

Habitat — In and along edges of different kinds of mountain forest and in shrubland, altitude 1800–3600(–4300) m.

Uses — The fruits are edible and have a pleasant taste.

Note — According to Borgmann, Zs. f. Bot. 52 (1964) 144 (sub *R. spec.*3), the species is high-ploid with $2n = c. 91$.

10. *Rubus banghamii* Merr., Contr. Arnold Arbor. 8 (1934) 68, pl. III. — Type: *Bangham 1163*, Tapanuli.

Semi-scandent shrubs. *Stems* glabrous, prickles rather few, curved, up to 5 mm. *Leaves* 3-foliate, upper ones simple and lobed, petiole 1.5–4 cm long. *Stipules* deeply 3- to 8-laciniate, lobes up to 12 mm long and up to 0.5 mm wide, glabrous. *Leaflets* elliptic, terminal ones 8–10 by 4–5 cm, lateral ones 6–8 by 2.5–4 cm, base acute, margin serrate, apex acuminate, herbaceous, 8–12 pairs of nerves, only short hairs on midrib above, otherwise glabrous. *Inflorescence* lax, up to 6 dichasia of up to 3(–6) flowers below the terminal flower. *Bracts* entire or like the stipules. *Pedicels* up to 6 cm long. *Hypanthium* c. 7 mm across (in fruit), glabrous and unarmed outside. *Sepals* triangular to triangular-ovate, 9–17 by 5–8 mm, entire, pointed, glabrous outside but woolly on the covered margins.

Petals not seen. *Stamens* c. 50, filaments up to 7 mm, anthers c. 1 mm long. *Pistils* c. 35, ovaries glabrous, on elevated, densely long-hairy torus, styles up to 5 mm long. *Collective fruits* ± ovoid, c. 1.5 cm, sepals spreading. *Fruits* up to 4 by 2.5 mm, red, mesocarp a thin membranous layer when dry.

Distribution — Sumatra.

Habitat — Primary forest, 1250–1400 m altitude.

Note — Insufficiently known species.

11. *Rubus chrysogaeus* P. van Royen, Phan. Mon. 2 (1969) 42, fig. 8. — Type: *Womersley & van Royen NGF 5919* = *van Royen 4334*, Edie Creek.

Sprawling to erect shrubs, up to 2 m. *Stems* glabrous, prickles up to 4 mm, slightly curved. *Glands* (sub)sessile, pale, on many parts of the plants. *Leaves* imparipinnate, with 2 or 3 opposite pairs of leaflets, often simple in the inflorescence, up to 17 cm long, petiole 0.8–5 cm long. *Stipules* linear, 6–9 by 0.5 mm, entire, ± glabrous. *Leaflets* ovate-lanceolate to lanceolate, 2–8 by 1–3 cm, base ± rounded, margin biserrate, apex long-tapering, papyraceous, 9–13 pairs of nerves, both sides sparsely hairy on main nerves only. *Inflorescences* with up to 4 monochasial or sometimes dichasial branches under the terminal flower, altogether up to 12 flowers. *Bracts* leaf-like to linear. *Pedicels* up to 4 cm long, glabrous, with some small prickles. *Hypanthium* up to c. 5 mm across, glabrous outside but with rather many sessile, yellow glands. *Sepals* narrowly triangular, 8–16 by 3–5 mm, incl. the long acumen, indumentum outside as hypanthium and woolly on the covered margins. *Petals* elliptic to obovate or spatulate, 8–12 by 3.5–5 mm, falling early, obtuse, shortly hairy outside, white. *Stamens* 70–80, filaments up to 5 mm, anthers 0.8 mm long. *Pistils* c. 500, ovaries (sub)glabrous and with pale glands, on elevated, hairy torus, style up to 1.5 mm long. *Collective fruits* globose to slightly ovoid, up to 1.5 cm, sepals spreading. *Fruits* up to 1 by 0.8 mm, red, mesocarp only a thin layer when dry.

Distribution — New Guinea, only known from the Eastern part of Papua New Guinea.

Habitat — Shrubland, forest borders, roadsides and similar rather open places, also recorded from grassland and forest, altitude 1200–2600 m.

12. *Rubus copelandii* Merr., Philipp. J. Sc. 1, Suppl. 3 (1906) 194 ('*copelandii*'); Elmer, Leaf. Philipp. Bot. 2 (1908) 457; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 227. — Type: *Merrill 4810*, Pauai.

Climbing or sprawling shrubs. *Stems* up to 4 m, with spine-like capitate hairs, otherwise glabrous, prickles many, up to 5 mm, straight to curved. *Leaves* 3-foliolate, in the inflorescence and at the base of laterals often simple and lobed, petiole 2.5–6.5 cm long. *Stipules* ovate to oblong, 7–15 by 2–7 mm, entire or with some teeth, with capitate hairs. *Leaflets* ovate, terminal ones 4–10 by 3–7 cm, lateral ones slightly smaller, base \pm rounded, margin (bi)serrate, apex acute to acuminate, herbaceous, 9–12 pairs of nerves, upper surface shortly hairy on main nerves and with long appressed hairs between them, lower surface glabrous. *Inflorescences* lax, up to 3 dichasia of up to 5 flowers under the terminal flower. *Bracts* stipule-like or 3-partite. *Pedicels* up to 6 cm long, with curved prickles and capitate spines. *Hypanthium* c. 5 mm across, glabrous outside but with straight prickles and capitate spines. *Sepals* triangular to ovate, 7–11 by 3–5 mm, entire, acuminate, indumentum outside as hypanthium and the covered parts woolly. *Petals* broadly elliptic to obovate, 9–12 by 7–9 mm, early falling, rounded, sometimes ciliolate, white. *Stamens* 80–100, filaments up to 5 mm, anthers c. 1 mm long. *Pistils* over 100, ovaries glabrous, on elevated, glabrous torus, style up to 2 mm long. *Collective fruits* ovoid, up to 2 by 1 cm, sepals spreading. *Fruits* up to 2 by 1.5 mm, dark red, mesocarp a thin membranous layer when dry.

Distribution – Luzon.

Habitat – More or less open places in forest, forest borders, thickets, altitude 1700–2450 m.

13. *Rubus ellipticus* J.E. Sm. in Rees, Cyclop. 30 (1815) *Rubus* spec. 16; Elmer, Leaf. Philipp. Bot. 2 (1908) 456; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 227; Backer & Bakh. f., Fl. Java 1 (1964) 515. — Type: *Hamilton s.n.*, Nepal.

Climbing or scrawling shrubs. *Stems* up to 4 m, densely woolly when young, with many patent red bristles (up to 8 mm long and glandular when young), prickles rather few, straight to slightly curved, up to 8 mm. *Leaves* 3-foliolate, the upper ones sometimes simple, petiole 1–7.5 cm long. *Stipules* linear, up to 10 by 0.5 mm, entire, hairy. *Leaflets* elliptic to orbicular, sometimes slightly ovate or obovate, terminal ones 4–9 by 3.5–9 cm, lateral ones 2–6.5 by 2–6.5 cm, base \pm rounded, margin (unequally) serrate, apex from acute to truncate, coriaceous, 7–10 pairs of nerves, patently hairy above, densely woolly and with longer straight hairs on the nerves below. *Inflorescences* rather lax, up to 30 cm long, with up to 12(–20)

much-branched laterals under the terminal flower, the whole inflorescence with up to 150 or more flowers. *Bracts* linear or 3-partite, hairy. *Pedicels* up to 1(–2) cm long, woolly, with bristles and curved prickles. *Hypanthium* 4–5 mm across, densely hairy and with bristles outside. *Sepals* ovate-triangular, 5–7.5 by 3–4.5 mm, entire, shortly acuminate, woolly and with longer hairs and at base also with bristles outside. *Petals* obovate to spatulate, up to 10 by 5 mm, early falling, rounded or acute, hairy, white. *Stamens* 30–40, filaments up to 2 mm, anthers c. 0.5 mm long. *Pistils* 100–150, ovaries on the back with many long straight hairs, especially near apex, on an elevated, densely hairy torus, style up to 2 mm long, hairy at base. *Collective fruits* ovoid to globose, up to 8 by 10 mm, sepals ultimately slightly spreading. *Fruits* up to 1.5 by 0.8 mm (dry), exocarp hairy, yellow to orange, mesocarp only a thin layer when dry.

Distribution – Continental Asia from India to China and Vietnam, Sri Lanka; *Malesia*: Philippines (Luzon). Introduced and naturalized in Java, Hawaii, Jamaica, Puerto Rico, Africa, Australia, and maybe elsewhere.

Habitat – In Luzon a species of oak and pine forest and in secondary growth, alt. 1000–2400 m.

Note – Root nodules from plants collected in Java showed nitrogenase activity and can be supposed to fix nitrogen under normal conditions. See J.H. Becking, Plant and Soil 53 (1979) 541–545.

14. *Rubus ferdinandi-muelleri* Focke, Abh. Naturw. Ver. Bremen 13 (1895) 165; P. van Royen, Phan. Mon. 2 (1969) 21, f. 2, pl. 1; Alpine Fl. New Guinea 4 (1983) 2464. — *Rubus ferdinandi* Focke, Bibl. Bot. 72 (1911) 162, nom. superfl. — Type: *MacGregor s.n.*, Papua New Guinea, not seen.

Rubus laeteviridis P. van Royen, Phan. Mon. 2 (1969) 29, f. 5. — Type: *Womersley & van Royen NGF 5901* = *van Royen 4332*, Wau.

Rubus woiatensis P. van Royen, Phan. Mon. 2 (1969) 39, f. 7. — Type: *van Royen NGF 20287*, Woiatpe-Kosibi.

Usually erect shrublets, sometimes climbing or scrambling. *Stems* up to 1.5 m, densely hairy to glabrous, prickles usually rather many, slender and spine-like, up to 1.5 cm long, reddish to purple. *Glands* sessile, red or yellow, sometimes present on many parts of the plant. *Leaves* imparipinnate, with 3–8(–9), usually opposite pairs of leaflets, up to 13 cm long, petiole 1–3.5 cm long. *Stipules* linear to lanceolate, 3–10 by 0.2–3 mm, entire

or with small teeth, acute to acuminate, glabrous. *Leaflets* ovate to elliptic, 1–5 by 0.5–2 cm, terminal one larger than lateral ones, base rounded to cuneate, margin (bi)serrate, apex acute, papyraceous to pergamentaceous, 5–9 pairs of nerves, upper surface glabrous or with short appressed hairs between and parallel with the lateral nerves, lower surface glabrous or soft-hairy on main nerves, sometimes with spines on the midrib. *Inflorescence* loosely branched with one or two 3- to 1-flowered cymes under the terminal flower, up to 5 cm long. *Bracts* stipule-like or 3-partite. *Pedicels* up to 3 cm long, hairy to glabrous, with spines. *Flowers* usually erect. *Hypanthium* c. 4 mm across, sparsely hairy to glabrous outside and with 1–5 purple spines alternating with the sepals. *Sepals* narrowly triangular, 5–9 by 1.5–3 mm, entire, (gradually) acuminate, indumentum outside as hypanthium and woolly on the covered parts. *Petals* obovate or elliptic to suborbicular, up to 9(–10) by 7 mm, early falling, rounded, glabrous or with few hairs, white. *Stamens* 30–35, filaments up to 3 mm, anthers c. 0.5 mm long. *Pistils* 120–180, ovaries glabrous or dorsally with some hairs, on an elevated, glabrous torus, style up to 2 mm long. *Collective fruits* ovoid to subglobose, up to 1 cm, sepals ultimately spreading. *Fruits* 1.5 by 1 mm, bright to dark red, mesocarp not very juicy and only a thin layer when dry.

Distribution — New Guinea, New Britain.

Habitat — Clearings in forest, forest edges, stream-banks, along tracks and roads, alt. (1550–) 1800–3000(–3465) m.

Note — The complex formed by *R. montis-wilhelmi*, *R. papuanus*, and *R. ferdinandi-muelleri* must be studied with biosystematical methods. The present delimitation of these three species is admittedly provisional.

15. *Rubus fraxinifolius* Poiret in Lam., Encycl. Méth. 6 (1806) 242; Blume, Bijdr. (1826) 1107; Miq., Fl. Ind. Bat. I, 1 (1855) 376; Elmer, Leaf. Philipp. Bot. 2 (1908) 460; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 227; Backer & Bakh. f., Fl. Java 1 (1964) 514; P. van Royen, Phan. Mon. 2 (1969) 45; Steenis, Mount. Fl. Java (1972) pl. 45-3. — Type: *Commerson s.n.*, Java.

[*Rubus moluccus parvifolius* Rumph., Herb. Amboin. 5 (1747) 88, t. 47, 1.]

Rubus celebicus Blume, Bijdr. (1826) 1107. — *Rubus fraxinifolius* Poir. subsp. *celebicus* (Blume) Focke, Bibl. Bot. 72 (1911) 151. — Type: (?) Reinwardt s.n. in L.

Rubus fraxinifolius Poir. var. *haightii* Elmer, Leaf. Philipp. Bot. 2 (1908) 461. — Type: (?) Mearns BS 4459, Pauai.

Rubus merrillii Focke, Bibl. Bot. 72 (1911) 153; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 228. — Type: Merrill BS 862 or BS 6637, Pauai.

Erect, rarely semi-scandent shrubs, up to 3 m high. *Stems* glabrous, unarmed or prickles few, straight, up to 6 mm. *Glands* (sub)sessile, sometimes present on leaves and other parts up to the flowers. *Leaves* imparipinnate, up to 27 cm long, with up to 4 (or 5) opposite pairs of leaflets, petiole 2–6 cm long. *Stipules* linear, 5–13 by 0.5–1 (–2) mm, entire or sparsely toothed, glabrate. *Leaflets* elliptic to oblong or ovate, 2–9(–12) by 1–4 (–6) cm, base usually rounded or cordate, margin serrate, apex acute or acuminate to long-pointed, papyraceous to pergamentaceous, (7–)10–15(–19) pairs of nerves, both sides sparsely hairy mainly on the nerves. *Inflorescence* lax and wide, up to c. 20 cm long and wide, with up to 7 branches under the terminal flower, the branches thyrsoid to cymes, the entire inflorescence with up to 60 flowers. *Bracts* lanceolate to 3-partite, up to c. 1 cm. *Pedicels* up to 5 cm long, glabrous, sometimes with small prickles. *Hypanthium* 5–6 mm across, glabrous and unarmed outside. *Sepals* triangular, 7–13 by 3–6 mm, including the 2–5 mm long acumen, entire, glabrous outside but woolly on covered margins. *Petals* orbicular to elliptic or obovate, 7–12 by 5–9 mm, falling early, glabrous, (greenish) white. *Stamens* up to more than 100, filaments up to 3 mm, anthers c. 1 mm long. *Pistils* up to more than 300, ovaries glabrous, torus elevated, basal part without pistils and long-hairy, upper part glabrous, style up to 1.5 mm long. *Collective fruits* ellipsoid to ovoid, up to 2.5 by 1.5 cm, sepals ultimately recurved. *Fruits* c. 1.5 by 0.8 mm (dry), (orange-)red, mesocarp a thin layer when dry.

Distribution — Taiwan; *Malesia*: Borneo, Java, Philippines, Celebes, Lesser Sunda Islands, Moluccas, New Guinea; Solomon Islands, Bismarck Archipelago.

Habitat — Forest borders and open places in forest, riverbanks, deserted gardens, roadsides, and other more or less open places, altitude 0–2500 m.

Uses — Although many collectors report on their labels that the fruits are tasteless or worse, they are at least in Java collected from the wild and sold for consumption. Heyne, Nutt. Pl. Indon. (1950) 693, mentions the use of the leaves in cases of slimy faeces (? dysentery, compare *Rubus moluccanus*).

Note – *Erinea*, as described under *R. rosifolius* (p. 266), also occur in the present species.

16. *Rubus lineatus* Reinw. ex Blume, Bijdr. (1826) 1108; Miq., Fl. Ind. Bat. I, 1 (1855) 378; Focke, Bibl. Bot. 72 (1910) 47, incl. var. *diengensis* Focke; Backer & Bakh. f., Fl. Java 1 (1964) 514; Steenis, Mount. Fl. Java (1972) pl. 45-4; Kalkman, Blumea 29 (1984) 322. — Type: *Reinwardt s.n.*, Java.

Rubus pulcherrimus Hook., Ic. Plant. 8 (1845) 729, 730. — Type: *Lobb s.n.*, Java.

Rubus lineatus Reinw. ex Blume forma *pulcherrimus* Focke in Hallier, Meded. Rijksherb. 14 (1912) 39. — Types: *Elbert 1087, 1681*, Lombok, *Gründler 2342*, Sumbawa.

Shrubs, up to c. 3 m high, sometimes ± climbing and up to 10 m. *Stems* densely long-hairy, prickles very few or none, up to 3 mm. *Leaves* pedately 5-foliolate, in the inflorescence sometimes fewer leaflets, young leaflets folded lengthwise, petiole 2–10 cm long. *Stipules* on the junction of twig and petiole, oblong to lanceolate, 2–4 by 0.5–1 cm, entire, cuspidate, hairy outside, falling early. *Leaflets* oblong to lanceolate, terminal ones 7–18 by 2–7.5 cm, lateral ones smaller, base acute, margin caudately serrate, apex acuminate to caudate, pergamentaceous, (20–)30–40(–50) pairs of nerves, upper surface variously hairy, lower surface always densely sericeous on main nerves, either short-woolly and also long-sericeous or quite glabrous between the nerves, the indumentum silvery. *Inflorescences* terminal and lateral thyrsi, up to 5 cm long and with up to 15 flowers. *Bracts* stipule-like. *Pedicels* up to 2 cm, densely sericeous. *Hypanthium* 5–9 mm across, densely sericeous outside. *Sepals* (ovate-)triangular, 6–13 by 2–7 mm, entire, long-pointed to acuminate, indumentum outside as hypanthium. *Petals* obovate to ± rhomboid, 4–5 by 2–3.5 mm, early falling, rounded, (greenish) white. *Stamens* 50–150, filaments up to 4 mm, anthers 0.7–1 mm long. *Pistils* c. 80 to over 100, ovaries long-hairy in apical part, on elevated, hairy torus, style up to 5 mm long, long-hairy. *Collective fruits* globose-ovoid, c. 1 cm in diam., sepals upright to slightly spreading. *Fruits* up to 2.5 by 2 mm (dry), exocarp hairy, orange to red, mesocarp juicy but only a thin layer when dry.

Distribution – Himalayas (Nepal to Arunachal), S China, Burma, Vietnam; *Malesia*: Sumatra, Borneo, Java, Lesser Sunda Islands.

Habitat – Lighter places in different forest types and in places like streambanks, landslides, roadsides, and shrubland, altitude 1400–3000(–3800) m.

Notes – In this treatment *R. lineatus* has been transferred from subg. *Malachobatus* (as in Focke, l.c. 1910, and Kalkman, l.c.) to subg. *Idaeobatus*. It is true that its stipules are not placed on the base of the petiole, usual in the latter subgenus, but rather on the junction of twig and petiole. However, its inflorescence is rather out of line in *Malachobatus*, not being a compound raceme but a dichasium or thyrses with di- to monochasial laterals.

The species seems to be most closely related to *R. alpestris* and *R. neo-ebudicus*. Its relationship to the former is also apparent from transitional specimens, probably hybrids, found in Borneo (*R. lineato-alpestris* Naruhashi & Sato, J. Phytogeogr. Taxon. 32, 1984, 102) and in Java (see Kalkman, l.c.).

Rubus satotakashii Naruhashi & Cheksun, J. Phytogeogr. Taxon. 32 (1984) 99, was interpreted by its authors as a hybrid with *R. lowii*, which – in view of the latter's relationship with *R. alpestris* – is certainly not improbable. Tawan, Sato & Naruhashi, J. Phytogeogr. Taxon. 39 (1991) 31, saw intermediate characters in the supposed hybrid, but also some unique ones.

17. *Rubus lorentzianus* Pulle, Nova Guinea 8 (1912) 647; P. van Royen, Phan. Mon. 2 (1969) 54; Alpine Fl. New Guinea 4 (1983) 2474. — Type: *von Römer 1276*, Hellwig Mts.

Climbing or scrambling shrubs, up to 4 m high. *Stems* long-hairy, glabrate, prickles many, straight, stout, up to 9 mm long, red. *Leaves* 3-foliolate, upper ones sometimes simple, petiole 1–5 cm long. *Stipules* ovate to lanceolate, usually oblique, 10–18 by 3–15 mm, entire to serrate, acute to caudate, hard, sometimes with prickles. *Leaflets* obovate, 2–7 by 1.5–3.5 cm, lateral ones shorter and relatively broader, margin serrate, apex rounded, rarely acute to acuminate, very stiff coriaceous, 4–8 pairs of nerves, both sides slightly hairy on main nerves when young, hairs often disappearing with age, leaflets often folded along the midrib. *Inflorescence* with up to 4 cymes below the terminal flower, cymes with 1–3 flowers, the whole inflorescence usually with less than 8 flowers. *Bracts* stipule-like. *Pedicels* up to 3 cm, hairy and with some prickles. *Hypanthium* up to 7 mm across, short-hairy and with many prickles outside. *Sepals* ovate to triangular, 9–14 by 5–8 mm, entire, caudate, rather sparsely hairy and with many long prickles outside, woolly on covered margins. *Petals* obovate to suborbicular, 8–11 by 6.5–9 mm, rounded, white. *Stamens* 30–45, filaments up to 5 mm, anthers c. 1 mm long. *Pistils* 15–45, ovaries gla-

brous, on elevated, hairy torus, style up to 4 mm long. *Collective fruits* ovoid, up to 1.5 cm across. *Fruits* up to 4.5 by 3 mm when dry, orange to red, mesocarp fleshy.

Distribution — New Guinea.

Habitat — Forest edges, openings in forest, shrubland, sometimes in grassland, altitude 2200–3650 (–3890) m.

Note — High-polyploid with $2n = 126$, according to one count by Borgmann, Zs. f. Bot. 52 (1964) 144, sub *Rubus spec.*

18. *Rubus lowii* Stapf in Hook., Ic. Plant. 23 (1894) t. 2289; Trans. Linn. Soc. Bot. 4 (1894) 145; Naruhashi & Sato, Tukar-Menakar 2 (1983) 14, incl. var. *panalabanensis* Naruhashi & Sato, nom. nud.; Naruhashi et al., J. Phytogeogr. Taxon. 32 (1984) 102, f. 3, incl. var. *panalabanensis* Naruhashi & Sato, descr. — Type: *Low s.n.*, Mt Kinabalu.

Climbing or scrambling shrubs. *Stems* up to 6 m, rather densely hairy, glabrate, prickles absent or few, stout. *Glands* sessile or stalked, sometimes present on all parts of the plants. *Leaves* 3-foliate, upper ones sometimes simple, petiole 0.7–2 cm long. *Stipules* lanceolate, 6–13 by 1.5–5 mm, long persistent, acute, entire or with small teeth, glabrous. *Leaflets* elliptic to elliptic-ovate, terminal ones 2–7 by 1–4 cm, lateral ones slightly smaller, base acute, margin serrate, apex acute to acuminate, coriaceous, 5–8 pairs of nerves, both surfaces with long hairs on main nerves, upper surface rarely also with hairs between nerves. *Inflorescence* with up to 4 few-flowered, axillary cymes below the terminal flower. *Bracts* stipule-like. *Pedicels* up to 3 cm long, hairy. *Hypanthium* c. 6 mm across, short-hairy outside. *Sepals* triangular to ovate, 8–11 by 4–6 mm, after anthesis slightly growing, \pm entire, caudate, acumen up to 3 mm long, sparsely hairy outside and with woolly covered margins. *Petals* obovate to suborbicular, 6–7 by 4–5.5 mm, rounded, white (to pinkish?). *Stamens* 30–45, filaments up to 5 mm, anthers c. 1 mm long. *Pistils* 15–25, ovaries glabrous, on slightly elevated, hairy torus, style up to 6 mm long. *Collective fruits* ovoid, c. 1.5 by 1 cm. *Fruits* up to 4 by 3 mm, red, mesocarp fleshy, tough when dry.

Distribution — Borneo, only seen from Mt Kinabalu.

Habitat — In open forest, forest edges, shrubland, altitude 3000–3960 m.

Note — Closely related to, maybe even conspecific with *R. macgregorii* from Celebes and New

Guinea. The latter species has distinctly armed stems and hairy ovaries. Both are also related to *R. alpestris* with 5-foliate leaves.

19. *Rubus macgregorii* F. Muell., Trans. Roy. Soc. Vict. 1, 2 (1889) 4; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 245; Merr. & Perry, J. Arnold Arbor. 21 (1940) 179; P. van Royen, Phan. Mon. 2 (1969) 52; Alpine Fl. New Guinea 4 (1983) 2472. — Type: *McGregor s.n.*, Mt Victoria, Papua New Guinea.

Creeping or scrambling small shrubs. *Stems* sparsely soft-hairy, glabrate, prickles rather few, curved, up to 2(–4) mm long. *Leaves* 3-foliate, upper ones sometimes simple, petiole 1–5 cm long. *Stipules* elliptic to elliptic-lanceolate, 5–12 by 1–5 mm, entire or toothed, acuminate to caudate, \pm glabrous. *Leaflets* obovate to elliptic, terminal ones 1.5–3.5 by 1–2.5 cm, lateral ones smaller, base narrowed, margin serrate, apex rounded with or without a short acumen, stiff coriaceous, 4–7 pairs of nerves, both surfaces very sparsely hairy on main nerves. *Inflorescences* poor, often only the terminal flower, sometimes 1 or 2 flowers below it. *Bracts* stipule-like. *Pedicels* up to 2 cm long, hairy and with some curved prickles. *Hypanthium* 5–6 mm across, sparsely hairy outside and with some straight, short prickles. *Sepals* ovate to triangular, 8–12 by 5–7 mm, growing after anthesis, entire, acuminate to 4 mm caudate, long-hairy outside and woolly on the covered parts. *Petals* obovate to orbicular, 8–9 by 7–8.5 mm, rounded, white. *Stamens* 40–50, filaments up to 4 mm, anthers c. 1 mm long. *Pistils* 30–40, ovaries long hairy on the dorsal side and at the top, on an elevated, hairy torus, style up to 3.5 mm long, with hairs at base. *Collective fruits* ovoid, up to 2 cm across. *Fruits* up to 4 by 3 mm, purple (?), mesocarp fleshy, a thin layer when dry.

Distribution — Celebes, Papua New Guinea.

Habitat — Thickets in grassland, altitude 2600–3600 m.

Note — See note under the related *R. lowii*.

20. *Rubus montis-wilhelmi* P. van Royen, Phan. Mon. 2 (1969) 19, f. 1; Alpine Fl. New Guinea 4 (1983) 2462. — Type: *Millar & van Royen NGF 14645*, Mt Wilhelm.

Rubus keysseri Schltr. ex Diels, Bot. Jahrb. 62 (1929) 481. See note.

Erect shrublets, \pm climbing or straggling when larger, up to 1(–1.5) m high. *Stems* sparsely hairy, glabrate, prickles spine-like, slender, up to 1(–1.5)

mm long, reddish. *Glands* (sub)sessile, red or yellow, usually scattered on many parts of the plant. *Leaves* up to 12 cm long, bipinnate to pinnate (to the apex) or sometimes tripinnate (at very base), primary pinnae 4–10, (sub)opposite, petiole 1–3 cm long. *Stipules* linear-lanceolate, 5–12 by 0.5–1.5 mm, (sub)glabrous. *Leaflets* 3–5 pairs on the primary pinnae, ovate to ovate-elliptic or elliptic-oblong, 2–10 by 1.5–6 mm, base acute, margin serrate to pinnatifid, apex usually acuminate, pergamentaceous, with 3–5 pairs of nerves, both surfaces glabrous or with few hairs. *Inflorescence* loosely branched with one or two 1- to 3-flowered cymes under the terminal flower, up to 5 cm long. *Bracts* linear, up to 3 mm. *Pedicels* up to 2 cm long, sparsely hairy and with spines. *Flowers* usually (sub)pendulous. *Hypanthium* up to 4.5 mm across, sparsely hairy and with some spines outside, the largest ones almost as long as and alternating with the sepals. *Sepals* narrowly triangular, 5–9 by 2–3.5 mm, long-pointed, entire, indumentum outside as hypanthium and very shortly woolly on the covered parts. *Petals* obovate to elliptic, falling early, up to 12 by 10 mm, rounded, white. *Stamens* 25–35, filaments up to 3 mm, anthers 0.5–0.8 mm long. *Pistils* 100–150, ovaries glabrous, on elevated, glabrous torus, style up to 1.5 mm long. *Collective fruits* ovoid to ellipsoid, up to 1 cm across, compact, sepals ultimately spreading. *Fruits* 1.5 by 1 mm, (dark) red, mesocarp not very juicy.

Distribution – Papua New Guinea.

Habitat – In (the edges of) subalpine and alpine shrubland and forests, altitude 2660–3660 m.

Note – Probably easily hybridizing with *R. ferdinandi-muelleri* and *R. papuanus*, see there. *Rubus keysseri* Schltr. was based on what looks like a hybrid specimen with the first-mentioned species (isotype seen from BM).

21. *Rubus neo-ebudicus* Guillaumin, J. Arnold Arbor. 12 (1931) 249. — Type: *Kajewski* 249, Tanna I.

Rubus brassii Merr. & Perry, J. Arnold Arbor. 21 (1940) 182; Zandee & Kalkman, Blumea 27 (1981) 105. — Type: *Brass* 2891, San Christobal.

Straggling or climbing, unarmed shrubs, up to 4 m high. *Stems* shortly woolly to glabrous. *Leaves* pedately 5-foliolate, the upper ones often 3–1-foliolate, petiole 2–5 cm long. *Stipules* (linear-)lanceolate, 5–10 by 1–3 mm, entire, glabrous or with hairs. *Leaflets* (oblong-)lanceolate, rarely ovate-lanceolate, terminal leaflet 8–14 by

2–4.5 cm, on 2–8(–15) mm long petiolule, lateral leaflets smaller, sessile or to 2 mm petioluled, base acute, margin mostly biserrate, apex acuminate, herbaceous, (16–)18–21(–26) pairs of nerves, sparsely hairy on both surfaces. *Inflorescence* lax, with up to 5 dichasial, up to 8-flowered branches under the terminal flower, up to 12 cm long. *Bracts* up to 1 cm, often toothed, those under the lateral dichasia usually 3-partite. *Pedicels* up to 2 cm long, all axes shortly woolly to glabrous. *Hypanthium* 5–6 mm across, sparsely hairy and sometimes with few short glandular hairs outside. *Sepals* narrowly triangular, 8–13 by 3–5 mm, acuminate to caudate (acumen up to 4 mm), entire, few hairs outside and covered margins woolly. *Petals* obovate to elliptic, 9–12 by 6–9 mm, falling early, obtuse, white. *Stamens* 45–100, filaments up to 4 mm, anthers c. 1 mm long. *Pistils* 80–100 or more, ovaries glabrous or with few hairs, on elevated, sparsely hairy torus, style up to 2.5 mm long. *Collective fruits* ovoid, up to 1 cm across, sepals upright. *Fruits* 2 by 1 mm when dry, orange to red, mesocarp only a thin layer when dry.

Distribution – New Ireland, New Britain, Solomon Islands, New Hebrides.

Habitat – Forest, altitude (180–)600–1700 m.

Uses – According to Woodley (ed.), Medicinal Plants of Papua New Guinea I. Morobe Prov. (1991) 120 (sub *R. brassii*) the extracted stem sap is drunk as a tonic by elderly people. Other species are, according to this source, used for the same purpose elsewhere.

Notes – Mr. P.S. Green (Kew) drew my attention to the conspecificity of the species reported from the New Hebrides with *R. brassii* from New Britain and the Solomon Islands.

The relationships of the present species seem to lie with *R. lineatus* and *R. alpestris*, which is peculiar since both species are absent from New Guinea and the Pacific.

22. *Rubus niveus* Thunb., Diss. Rubo (1813) 9, f. 3; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 229; Backer & Bakh. f., Fl. Java 1 (1964) 515; Lauener & Ferg., Not. Roy. Bot. Gard. Edinb. 30 (1970) 276; Steenis, Mount. Fl. Java (1972) pl. 45–5. — Non *Rubus niveus* Wall. ex Hook. f., Fl. Brit. India 2 (1878) 335 = *Rubus hypargyris* Edgew. — Type: *Thunberg* s.n., Java.

Rubus horsfieldii Miq., Fl. Ind. Bat. I, 1 (1855) 375, t. 7; Koord., Nat. Tijds. Ned. Indië 60 (1901) 276. — *Rubus niveus* Thunb. subsp. *horsfieldii* (Miq.) Focke, Bibl. Bot. 72 (1911) 183. — Type: *Horsfield* s.n., Java.

Usually erect, sometimes climbing shrubs, up to 2 m high, the often drooping branches up to 3.5 m long. *Stems* sparsely hairy, glabrescent, prickles usually rather few, straight to curved, up to 7 mm. *Leaves* imparipinnate, up to 27 cm long, petiole 1.5–5 cm long. *Stipules* (linear-)lanceolate, 6–16 by 1–3(–5) mm, slightly hairy to glabrous. *Leaflets* 2–4(–5) opposite pairs, elliptic or rhombic to ovate, sometimes ovate-lanceolate, 2–8 by 1–4 cm, base usually acute, margin serrate to biserrate but the basal part often entire, apex acute to acuminate, papyraceous to pergamentaceous, 6–9 pairs of nerves, soft-hairy above but soon glabrate, lower surface with a woolly silvery-white felt of short curly hairs all over and with longer straight hairs on main nerves. *Inflorescence* usually rich and branched, a compound leafy thyrses up to 20 cm long. *Bracts* stipule-like. *Pedicels* up to 1.5 cm, hairy. *Hypanthium* 2–3 mm across, hairy outside. *Sepals* triangular, 4–7 by 1.5–2.5 mm including the up to 2 mm long acumen, densely woolly outside, acumen mostly glabrous. *Petals* falling rather early, suborbicular, 3.5–5 by 3–3.5 mm, 1 mm clawed, pink. *Stamens* 25–35, filaments up to 4 mm, anthers c. 0.5 mm long. *Pistils* 50–75 or more, ovaries rather densely long-hairy, on elevated, hairy torus with pistils down to the base, style up to 3 mm long. *Collective fruits* globular to broadly ovoid, up to c. 1 cm across, compact, sepals spreading. *Fruits* c. 2.5 mm long, exocarp densely hairy, red but the colour masked by the dark (blue to blackish) hair-cover, mesocarp only a thin layer when dry.

Distribution – Continental Asia from Kashmir to Vietnam, Sri Lanka, Taiwan; **Malesia**: Sumatra, Java, Lesser Sunda Islands, Luzon, Celebes. Introduced and naturalized in Southern and Eastern Africa (Stirton, Bothalia 13, 1981, 346). Introduced and cultivated in peninsular Malaysia where it became naturalized on Fraser's Hill, Pahang. Introduced and (recently) cultivated near Kainantu, Eastern Highlands Prov., Papua New Guinea (R.H. Converse, in litt. 1986). Also cultivated for the fruits in Florida, USA ('Mysore raspberry'), maybe also elsewhere.

Habitat – Open and half-shaded places like hedges, shrubland, grassfields, abandoned gardens, roadsides, *Eucalyptus* savannas, rarely in forest, altitude (600–)1000–2900 m.

Uses – Fruits edible, see also under *Distribution*.

Notes – The species is on the Asian continent more variable than in Malesia where infraspecific taxa cannot be recognized. The synonymy given above is incomplete for the continent.

In some of the specimens from Timor the woolly indumentum on the underside of the leaflets is missing, but there are dots and patches of dense long hairs, possibly galls.

23. *Rubus papuanus* Schltr. ex Diels, Bot. Jahrb. 62 (1929) 481; Merr. & Perry, J. Arnold Arbor. 21 (1940) 182; P. van Royen, Phan. Mon. 2 (1969) 26, f. 4; Alpine Fl. New Guinea 4 (1983) 2470. —Type: *Keysser* 36, lost; neotype: *Brass* 4246, Mt Albert Edward.

Erect or scrambling small shrubs, up to 80 cm high. *Stems* soft-hairy, glabrescent, prickles straight, slender, spine-like, up to 1 cm, red. (Sub-)sessile red or yellow *glands* often present on many parts. *Leaves* imparipinnate, up to 10 cm long, petiole 0.5–1(–1.5) cm long. *Stipules* oblong to linear-lanceolate, 4–9 by 1–3 mm, glabrous. *Leaflets* 6–9(–10) (sub)opposite pairs, (broadly) ovate, 6–15 by 4–9 mm, base rounded to cuneate, margin rather deeply serrate, apex pointed to acuminate, pergamentaceous, 3–5 pairs of nerves, both surfaces glabrous or almost so. *Inflorescence* poor, at most 1 or 2 axillary flowers under the terminal one. *Pedicels* up to 2.5 cm long, soft-hairy. *Flowers* more or less pendulous. *Hypanthium* up to 6 mm across, soft-hairy to glabrous outside and with some spines, the largest of those up to c. 1 cm, alternating with the sepals. *Sepals* narrowly triangular, 6–11 by 2–4 mm including the up to 3 mm long acumen, indumentum outside as hypanthium and woolly on the covered parts. *Petals* falling early, broadly obovate to orbicular, 6–12(–18) mm long, rounded or retuse, white. *Stamens* 20–50, filaments up to 3 mm, anthers c. 0.8 mm long. *Pistils* 70–100, ovaries glabrous or dorsally with few hairs, on elevated, glabrous torus with pistils down to the base, style up to 1.5 mm long. *Collective fruits* ovoid, up to 2 by 1.5 cm, sepals ultimately spreading. *Fruits* up to 2.5 mm long, bright red, mesocarp fleshy but only a thin layer when dry.

Distribution – New Guinea, New Ireland. In 1965 introduced in England (Grasmere, Westmorland) and there it is hardy.

Habitat – Subalpine and alpine shrubland, grasslands, open places in forest, and forest edges, altitude (2100–)3000–3650 m.

Note – This may be a high altitude form of *R. ferdinandi-muelleri*. See the notes there and to *R. montis-wilhelmi*.

24. *Rubus rosifolius* J.E. Smith, Pl. Icon. Hact. Ined. 3 (1791), t. 60, '*rosaefolius*' as in

- many other references; Blume, Bijdr. (1826) 1107; Hook., Ic. Plant. 4 (1840) t. 349; Miq., Fl. Ind. Bat. I, 1 (1855) 375; Elmer, Leaf. Philipp. Bot. 2 (1908) 462; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 230; Ochse, Fruits (1931) 107, pl. 42; Backer & Bakh. f., Fl. Java 1 (1964) 515, excl. subsp. *sumatranus* Focke; P. van Royen, Phan. Mon. 2 (1969) 34; Steenis, Mt. Fl. Java (1972) pl. 45–3; Kalkman in Steenis (ed.), Blumea 28 (1982) 168 (reduction of Gilli names). — Type: *Commerson s.n.*, Mauritius.
- Rubus rosifolius* J.E. Smith var. *coronarius* Sims, Curt. Bot. Mag. (1816) t. 1783; Backer & Bakh. f., Fl. Java 1 (1964) 515. — Type: plate and description in Sims, l.c.
- Rubus javanicus* Blume, Bijdr. (1826) 1108. — Type: *Blume 1571*, Java.
- Rubus tagallus* Cham. & Schlechtend., Linnaea 2 (1827) 9; Elmer, Leaf. Philipp. Bot. 2 (1908) 461; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 230. — Type: *de Chamisso s.n.*, Luzon.
- Rubus apoensis* Elmer, Leaf. Philipp. Bot. 5 (1913) 1618. — Type: *Elmer 10464*, Mindanao.
- Rubus mingendensis* Gilli, Ann. Naturhist. Mus. Wien 83 (1980) 457, incl. var. *trichocarpa* Gilli, nom. nud., inval. — Type: *Gilli 111*, Papua New Guinea, Chimbu.
- Rubus × dosedlae* Gilli, l.c. 456. — Type: *Dosedla 45A*, Papua New Guinea, Mt Hagen.

Erect or scrambling, rarely climbing shrubs, up to 1(–3) m high. *Stems* soft-hairy, glabrescent, prickles usually rather few, curved to straight, 1–5 mm. Sessile, pale yellow *glands* usually present on many parts of the plants. *Leaves* imparipinnate, up to 18 cm long, petiole 1–5.5 cm long. *Stipules* linear, 4–9 by 0.5–1 mm, entire. *Leaflets* in (1–) 2–3(–4) opposite pairs, ovate to ovate-oblong, sometimes elliptic to oblong, 2–6 by 1–2.5 cm, terminal leaflets up to 8 by 4 cm, base acute to cordate, margin biserrate, apex acute to long-tapering, papyraceous, (4–)7–9(–11) pairs of nerves, both surfaces soft-hairy. *Inflorescence* with up to 4 dichasia in the axils of the upper (reduced) leaves, rarely longer than 10 cm, with up to 10 flowers. *Pedicels* up to 4 cm long, hairy. *Hypanthium* 4–6.5 mm across, with scattered hairs and many glands outside. *Sepals* ovate to narrowly triangular, 7–15 (–22) by 2–5 mm, including the up to 5 mm acumen, entire, indumentum outside as hypanthium and shortly woolly on the covered margins. *Petals* falling early, broadly obovate to ovate, 8–17 by 6–12 mm, obtuse, white. *Stamens* 60–140, filaments up to 8 mm, anthers 0.5–0.8 mm long. *Pistils* up to c. 600, ovaries with some apical hairs

and usually many shortly stalked pale glands, on elevated, hairy torus with pistils down to the base, style up to 2 mm long. *Collective fruits* ovoid to globose or ellipsoid, up to 2.5 cm across, sepals recurved. *Fruits* c. 1.5 mm long when dry, red, mesocarp juicy, only a thin layer when dry.

Distribution – Continental Asia (Assam, Cambodia, Vietnam), Japan (?), Taiwan, New Britain, New Ireland, New Hebrides, New Caledonia, Australia (Queensland, New South Wales); in *Malesia*: Borneo, Java, Philippines, Celebes, Lesser Sunda Islands, New Guinea, Bougainville. Introduced and naturalized in many parts of the world: Africa, C & S America, island groups in the Pacific and Indian Ocean.

Habitat – In open (secondary, anthropogenic) places like clearings, forest-edges, roadsides, landslides, grassland, riverbanks, fallow gardens, also in shrubland and rarely in the undergrowth of lighter types of forest, altitude 0–2000(–2400) m, in Celebes also reported from 2800–2900 m.

Uses – Because of its easy growth, nice flowers and edible fruits often cultivated in sunny gardens, within and outside its natural area. Quisumbing, Medic. Pl. Philipp. (1951) 354, records the use of a decoction of roots as an expectorant.

Notes – Garden-forms exist with more than 5 petals in the flower, which resembles a small rose. They are usually called var. *coronarius* Sims. These plants may produce fruits and have sometimes escaped from cultivation.

Some specimens possess remarkable erineae, consisting of dots of a very dense indumentum on the leaves, probably caused by the gall-mite *Eriophyes rubierineus*. See Docters van Leeuwen, Zoocecidia (1926) 220. The same kind of erineae is also found in some other species.

- 25. *Rubus sumatranus*** Miq., Sumatra (1861) 307; Lauener & Ferg., Not. Roy. Bot. Gard. Edinb. 30 (1970) 280. — *Rubus rosifolius* J.E. Smith subsp. *sumatranus* (Miq.) Focke, Bibl. Bot. 72 (1911) 155; Backer & Bakh. f., Fl. Java 1 (1964) 515. — Type: *Teijsmann s.n.*, Sumatra.
- Rubus asper* auct. non Wall. ex D. Don: Focke, Bibl. Bot. 72 (1911) 157, f. 67; Backer, Schoolfl. Java (1911) 454.

Erect or scrambling to semi-scandent shrubs, up to 2 m high. *Stems* with many up to 5 mm long gland-tipped, reddish, setose hairs and usually also with soft, curly hairs, prickles usually not many, curved, up to 5 mm. Sessile, pale or red globular *glands* often present on many parts of the plant, especially the leaves. *Leaves* imparipinnate, up to

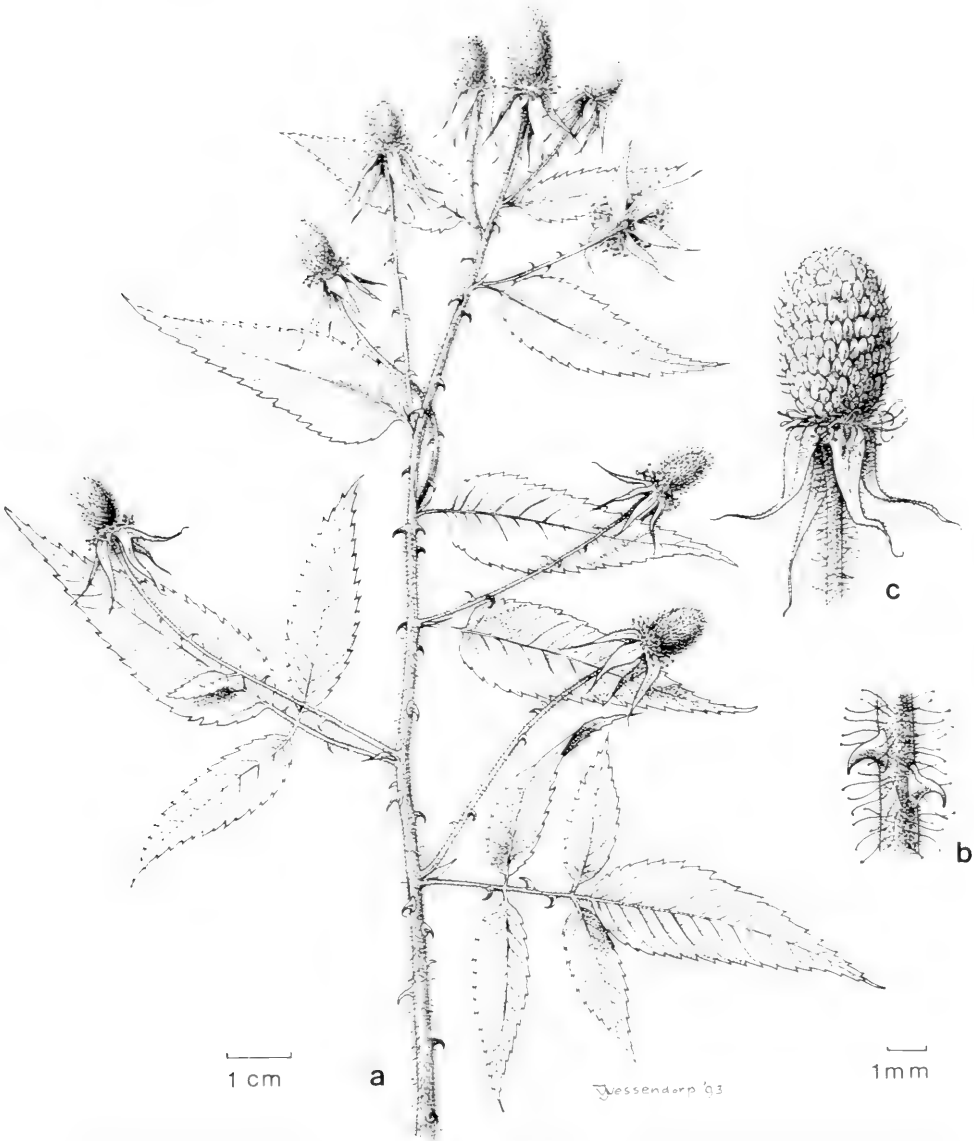


Fig. 3. *Rubus sumatranus* Miq. a. Branch with old flowers; b. stem with prickles and glandular hairs; c. collective fruit (a, b: Lörzing 4753; c: Kochummen FRI 16456).

21 cm long, petiole (1–)2–6 cm long. *Stipules* linear, 3–6 by up to 0.5 mm, entire. *Leaflets* in 2–3(–4) opposite pairs, oblong to oblong-ovate, 2.5–7 by 0.8–2 cm, base acute to rounded, margin serrate to biserrate, apex acute to long-tapering, herbaceous, 7–12 pairs of nerves, soft-hairy on both surfaces and with gland-tipped long hairs.

Inflorescence consisting of up to 5(–8) cymes in the axils of the upper leaves, up to 25 cm long, with up to 20 flowers. *Bracts* in the cymes often leaf-like. *Pedicels* up to 4 cm long. *Hypanthium* 4–5 mm across, with some soft hairs and with gland-tipped setose hairs outside. *Sepals* narrowly triangular, 7–14 by 2–3.5 mm, including the up

to 5 mm long acumen, indumentum outside as hypanthium and also woolly on the covered margins. *Petals* falling early, oblong to obovate, 8–10 by 2–4 mm, obtuse, slightly fimbriate at apex, white. *Stamens* up to c. 120, filaments up to 4 mm, anthers 0.5 mm long. *Pistils* up to c. 500, ovaries glabrous, on elevated, glabrous torus with pistils down to the base, style up to 2 mm long. *Collective fruits* ellipsoid, up to 1.5 by 0.8 cm when dry, sepals recurved. *Fruits* 1–1.5 mm long, orange-red to red, mesocarp only a very thin layer when dry. — **Fig. 3.**

Distribution — NE India, Thailand, Laos, Vietnam, S China, Taiwan, Japan; in *Malesia*: Sumatra, Peninsular Malaysia, Java.

Habitat — Clearings, roadsides, thickets, tea plantations, forest borders, and similar open places, very rarely reported from lighter types of forest, altitude (Sumatra and Malaya) 500–2000 m.

Uses — Fruits edible, pleasant of taste.

Note — Confused with *R. croceacanthus* Léveillé (*R. asper* Wall. ex D. Don 1825, nom. illeg., non Presl 1822) from continental Asia.

Subgenus *Malachobatus*

Rubus subg. *Malachobatus* (Focke) Focke, Bibl. Bot. 72 (1910) 41; Kalkman, Blumea 29 (1984) 319. — *Rubus* sect. *Malachobatus* Focke, Abh. Naturw. Ver. Bremen 4 (1874) 187, 201.

Leaves mostly simple (in Malesia always), entire or lobed, usually pedately nerved with on either side at the very base of the midrib 2 or 3 main side nerves, each with 2–5 basicopic lateral nerves, above the base pinninerved, nerves usually terminating in the margin, nervation more rarely palmate with 3–7 main nerves, or pinnate. *Stipules* free, on the twig near the petiole-base, usually rather persistent. *Inflorescences* terminal, compound racemes or thyrses, side branches racemose or di- or monochasial, the lower branches axillary to leaves. *Flowers* usually bisexual, some species (gyno)dioecious. *Hypanthium* saucer- to cup-shaped. *Sepals* subequal or inner ones distinctly narrower, entire or (usually) with up to 5 teeth on the not-covered margins. *Petals* in some species wanting or only one left. *Fruits* cohering, falling as a whole together with the dried torus.

Distribution — Many species (c. 80?), centred in Continental Asia and Malesia, extending to Japan, Australia, and the W and SW part of the Pacific Ocean. In *Malesia* 19 species and some incompletely known ones (see Kalkman, l.c.). New Guinea is poor in species belonging to this subgenus, which contrasts with the two other subgenera.

26. *Rubus alceifolius* Poiret in Lam., Encycl. Méth. 6 (1806) 247, '*alcaefolius*, *alceaefolius*', the latter orthography also in many other references; Blume, Bijdr. (1826) 1109; Miq., Fl. Ind. Bat. I, 1 (1855) 379; Suppl. 1 (1860/61) 116, 308; Kuntze, Meth. Speciesbeschr. (1879) 56; Ridley, Fl. Mal. Penins. 1 (1922) 677; Backer & Bakh. f., Fl. Java 1 (1964) 516. — *Rubus moluccanus* L. var. *alceifolius* (Poiret) Kuntze, Rev. Gen. Pl. 1 (1891) 222. — Type: *Commerçon s.n.*, Java.

Shrubs with arching or climbing branches up to 5 m long. *Stems* rather densely covered with patent and straight hairs, mixed with shorter and thinner

hairs and with stalked glands, prickles usually rather many, stout. *Leaves* orbicular to broadly ovate in outline, (10–)12–26 by (9–)12–26 cm, 5–7-lobed with up to 4 cm deep incisions, lobes rounded and shallowly lobed, base deeply cordate, margins grossly and evenly serrate, apex obtuse to acute, herbaceous to slightly coriaceous, nervation pedate with 5–7 pairs of nerves, venation reticulate, sometimes the upper surface distinctly bullate between the veins, upper surface hairy, lower surface with a usually closed felt of short, curly hairs and with many long, patent hairs on the nerves. *Petiole* 3–11 cm long. *Stipules* often rather persistent, orbicular in outline, up to c. 2 cm, deeply digitately divided with the lobes pinnate, lobes

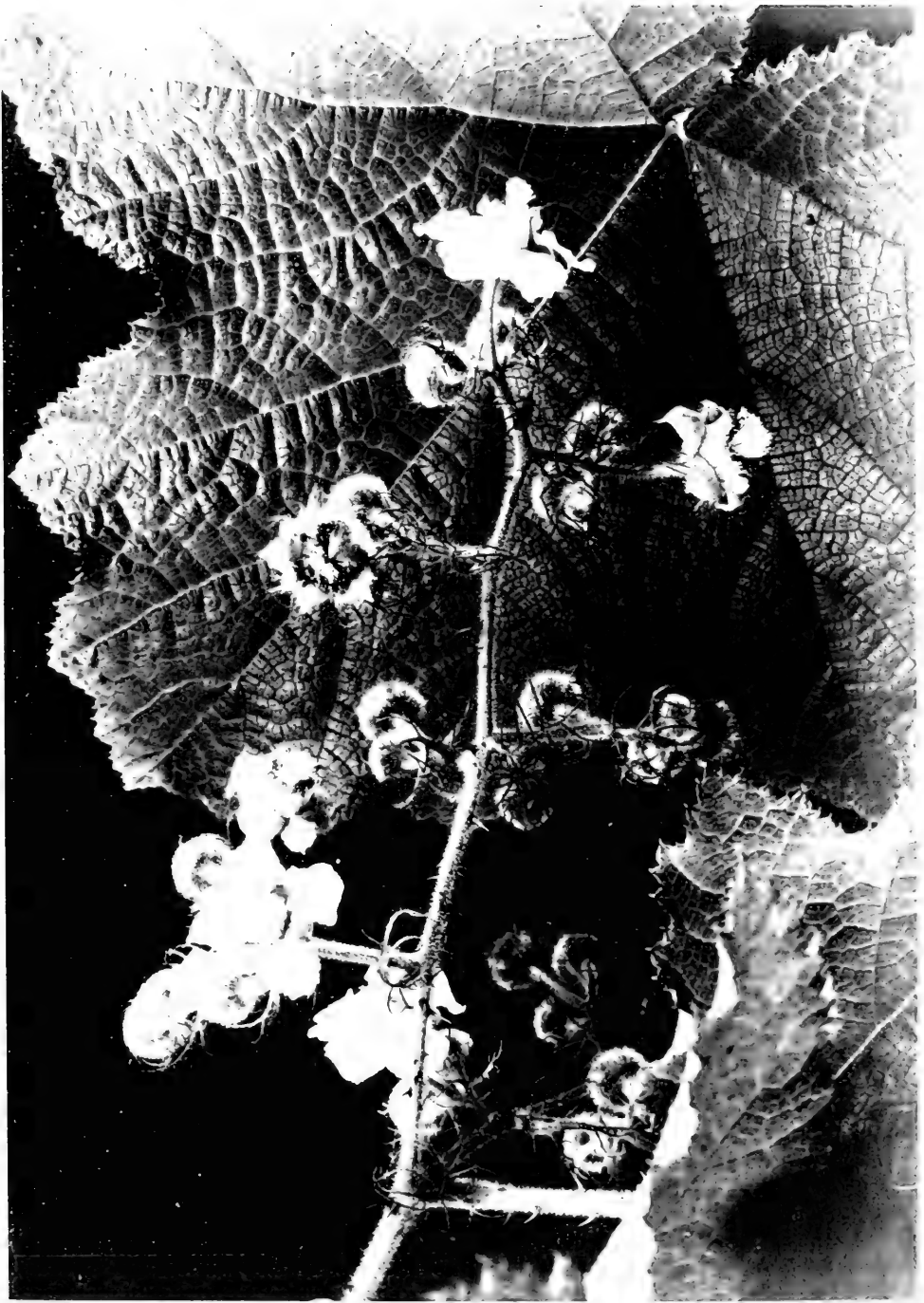


Fig. 4. *Rubus alceifolius* Poir. Inflorescence and leaf. Mt Salak, Java. Photo J. H. Becking.

thread-like, at most 0.3 mm wide, hairy outside and on margins. *Inflorescence* a terminal compound raceme with 12 or more laterals, the lower of them in the axils of leaves, up to 50 cm long, the lateral racemes up to 12 cm long, all axes terminating in a flower. *Bracts* rather persistent, pinnatifid to -partite, with thin lobes. *Pedicels* 1–1.5 cm long, densely hairy as are all axes in the inflorescence. *Flowers* bisexual, flower buds ± globular. *Hypanthium* cup-shaped, 6–9 mm across, densely woolly and with long patent hairs outside. *Sepals* ovate, 6–10 by 4–7 mm, acute to acuminate, not-covered margins with 2–5 teeth up to 2(–4) mm long, indumentum outside as hypanthium. *Petals* early falling, orbicular, 5.5–9.5 by 4.5–9 mm, distinctly clawed, rounded or notched at apex, white. *Stamens* 160–230, filaments up to 5 mm, anthers 0.5–0.8 mm long, with long hairs. *Pistils* up to 150, ovaries glabrous, on elevated, glabrous torus, style up to 10 mm long. *Collective fruits* globular, c. 1 cm, sepals under ripe fruits spreading. *Fruits* 2–4 by 2–3 mm when dry, red, mesocarp juicy, a thin layer when dry. — **Fig. 4.**

Distribution — China, Taiwan, Burma, Thailand, Laos, Cambodia, Vietnam; *Malesia*: Sumatra, Malaya, Borneo, Java, Celebes, Lesser Sunda Islands. Introduced in Australia (Queensland), Madagascar, and Mascarenes.

Habitat — In light places like forest edges, roadsides, secondary forest, thickets, and riverbanks, altitude (0–)500–1400(–1600) m.

Uses — Shoots are eaten (Sumatra), a kind of use which is rarely mentioned for species of *Rubus*. Roots of the species are boiled and taken against dysentery (Malaya).

Note — *Rubus alceifolius* differs from all varieties and forms of the related *R. moluccanus* in the shape of the closed flowerbuds (globular, not ovoid-pointed) and in the stipules which have very thin, filiform lobes.

27. *Rubus beccarii* Focke, Bibl. Bot. 72 (1910) 62. — Type: *Beccari* 175, Sumatra.

Probably large, climbing shrubs. *Stems* densely hairy, prickles rather many, rather small. *Leaves* ovate, 9–11.5 by 6.5–7.5 cm, not lobed, base shallowly cordate, margin serrate, apex acute to shortly acuminate, rather thick and firm, nervation pinnate or pedate, with 7 or 8 pairs of nerves, those not always terminating in the margin, venation transverse, upper surface long-hairy, lower surface with many long, straight, patent hairs and with few short, curly hairs. *Petiole* c. 2 cm long, hairy.

Stipules c. 1 cm long, deeply divided, lobes thin. *Inflorescence* only fragmentarily known, axes densely hairy. *Flowers* possibly functionally unisexual, only males seen, flower buds globular. *Hypanthium* c. 5 mm across, densely hairy outside with woolly felt and long, straight hairs. *Sepals* broadly ovate, up to 6 by 6 mm, uncovered margins with c. 5 small teeth, covered margins entire, indumentum outside as hypanthium. *Petals* 7 by 6 mm (not full-grown), rounded apex. *Stamens* c. 115, glabrous, anthers 1 mm long. *Pistils* many, not developed in male flowers, pistillodes long-hairy on back and in basal part of style. *Collective fruits* not seen.

Distribution — Only known from the type specimen from Mt Singgalang in West Sumatra. Closely allied to, and maybe conspecific with *R. smithii*.

28. *Rubus benguetensis* Elmer, Leaf. Philipp. Bot. 1 (1908) 296; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 227. — Type: *Elmer* 8383, Luzon.

Climbing or scrambling shrubs. *Stems* up to 15 m long, young twigs (rather) densely covered with patent and with curly hairs mixed with glandular hairs, prickles few to rather many, small. *Leaves* ovate to elliptic, (6–)7.5–13 by (3.5–)5–8 cm, not lobed, in sterile shoots up to 17 by 9 cm and shallowly 3-lobed, base cordate to subtruncate, margin evenly serrate, apex acute to shortly acuminate, herbaceous to stiffly coriaceous, nervation pinnate with up to 6 pairs of nerves, sometimes ± pedate, venation transverse, both surfaces more or less densely hairy at least on nerves and veins. *Petiole* 0.5–1(–1.5) cm long. *Stipules* often rather persistent, pinnatisect to -partite with 2–4 pairs of lobes, up to 9 by 3 mm. *Inflorescence* laxly paniculate, a compound raceme with the ultimate branching sometimes cymose, up to c. 20 laterals with up to 30 flowers, the lowermost laterals in the axils of leaves, the entire inflorescence up to c. 35 cm long, the laterals up to 15 cm. *Bracts* usually tripartite, up to c. 8 mm long. *Pedicels* 0.7–1.5 cm long, densely hairy as are the branches of the inflorescence. *Flowers* bisexual, flower buds ovoid. *Hypanthium* saucer-shaped, 3.5–4 mm across, shortly woolly outside and also with long hairs. *Sepals* ovate, sharply pointed, 6–7 by 2.5–5 mm, inner ones narrower than outer ones, covered margins entire, outer margins with usually one minute tooth under the apex, indumentum outside as hypanthium, the outside pink to purple as are the pedicels. *Petals* none, rarely one or a semi-petaloid stamen. *Stamens* 50–80, glabrous, filaments up to 5 mm, anthers 0.5–0.8 mm long.

Pistils (13–)20–30, glabrous, ovaries on slightly elevated, hairy torus, style up to 5 mm long. *Collective fruits* globular, up to 8 mm diam., sepals closing after anthesis. *Fruits* 3.5–6 by 2–2.5 mm when dry, black, mesocarp probably fleshy and rather thick but when dry only a thin, tough layer.

Distribution — Borneo (seen from Sarawak, Sabah), Luzon, C and S Celebes.

Habitat — Primary forest on slopes, also on open cliffs, altitude (150–)600–2900 m.

Ecology — Several collections seen from limestone but also on other soil types.

29. *Rubus chrysophyllus* Reinw. ex Miq., Fl. Ind. Bat. I, 1 (1855) 380; Kuntze, Meth. Speciesbeschr. (1879) 56, 76; Backer & Bakh. f., Fl. Java 1 (1964) 516; Steenis, Mount. Fl. Java (1972) pl. 45-2. — *Rubus moluccanus* L. var. *chrysophyllus* (Reinw. ex Miq.) Kuntze, Rev. Gen. Pl. 1 (1891) 222. — Types: *Reinwardt s.n.*, *holo*; *Junghuhn s.n.*; both Java.

Rubus moluccanus L. var. *ochraceus* Blume, Bijdr. (1826) 1109. — Type: *Blume s.n.*, Java.

Shrubs, up to 4 m high, overhanging branches up to 10 m long. *Stems* with a dense yellowish indumentum of short, curly hairs and long, (semi-) appressed, straight or wavy hairs, glabrate, prickles few, short, or twigs unarmed. *Leaves* ovate to broadly ovate, 7–22 by 7–18 cm, shallowly 3–7-lobed, base truncate to shallowly cordate, margins grossly and unevenly serrate, apex acute, stiff-coriaceous, nervation pedate with 6–9 pairs of nerves, venation reticulate, on upper surface the squarish intervenial fields distinctly bullately raised, upper surface soon glabrous, lower surface with a dense, closed felt of short, curly hairs and on nerves and veins many straight, (semi-) appressed hairs, distinctly two-coloured when dry. *Petiole* 2–7 cm long. *Stipules* often persistent, orbicular in outline, digitately and deeply divided into 6–8 lobes, the largest of those pinnatifid, 1–1.5 cm long, hairy. *Inflorescence* panicle-like, a compound raceme with di- or monochasial last branches, up to 12 side-branches, the lower ones in the axils of leaves, the entire thyrses up to 35 cm long, side-branches up to 17 cm long. *Bracts* large, deeply dentate. *Pedicels* 1–2(–4) cm long, densely hairy as all axes in the inflorescence. *Flowers* bisexual, flower buds ovoid, pointed. *Hypanthium* cup-shaped, (4–)5–7 mm across, densely hairy outside with long, straight hairs hiding the smaller curly ones. *Sepals* triangular, pointed, outer ones (4–)6–8 by 3–6 mm, inner ones narrower, uncovered margins with (2–)3–5 teeth, up to 1.5 mm long,

indumentum outside as hypanthium. *Petals* orbicular to elliptic, 3–7.5 by 2.5–5.5 mm, apex notched, white. *Stamens* 50–100, glabrous, filaments up to 4 mm, anthers 0.5–0.8 mm long. *Pistils* 50–90, ovaries glabrous, on elevated, densely hairy torus, style up to 5.5 mm long. *Collective fruits* globular, up to 7 mm diam. when dry, sepals closing after anthesis. *Fruits* curved, c. 2.5 by 1.5 mm when dry, glabrous, yellow to orange, sometimes red, mesocarp juicy, a thin layer when dry.

Distribution — Sumatra, Java, Lombok.

Habitat — Light forest and more open places like thickets, forest edges, clearings, secondary bush, and near craters. Montane, altitude (900–)1200–2950 m.

Uses — The fruits seem to be delicious.

Notes — Some specimens from Java have only female flowers.

The bullate leaves, the rather stout and coarse habit, and the wide and lax inflorescences separate the species rather clearly from the related *R. moluccanus*.

30. *Rubus cumingii* Kuntze, Meth. Speciesbeschr. (1879) 72, 76; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 227. — Type: *Cuming s.n.*, Philippines.

Shrubs, dimensions unknown. *Stems* with some vestiges of thin, curly hairs and also with long and thicker hairs, prickles rather many, small. *Leaves* ovate, not lobed, 7–8 by 5–6 cm, base subtruncate, margin serrate, apex acute, herbaceous, nervation pedate with 7 pairs of nerves, venation transverse, both sides with long (semi-) appressed hairs on the nerves and fewer on and between the veins. *Petiole* 1.5 cm long. *Stipules* elliptic, entire. *Inflorescence* panicle-shaped, c. 15 cm long and wide, with 4 side branches, rich-flowered, densely patently hairy. *Bracts* persistent. *Pedicels* c. 3 mm. *Flowers* unisexual, flower buds ovoid. *Hypanthium* cupular, c. 5.5 mm across, densely hairy outside. *Sepals* broadly ovate, pointed, outer ones 5 by 4 mm, inner ones narrower, uncovered margins with one short tooth, indumentum outside as hypanthium. *Petals* persistent, elliptic, 3.5 by 2 mm. *Stamens* not seen, *staminodes* in female flowers c. 60, glabrous. *Pistils* 14, ovaries long-hairy on the back near the apex, on little elevated, hairy torus, style c. 2.5 mm long, hairy at base. *Collective fruits* not known. *Fruits* c. 2.5 by 1.5 mm.

Distribution — Known from one duplicate of the type, probably from Luzon, with female flowers.

Note – *Steiner 2027* (Luzon) and *Beguín 1546* (Ternate) may be conspecific but differ in details of the indumentum. Related to *R. luzoniensis*.

31. *Rubus elongatus* J.E. Smith, Pl. Icon. Hact. Ined. 3 (1791) t. 62; Blume, Bijdr. (1826) 1112; Miq., Fl. Ind. Bat. I, 1 (1855) 380, incl. varieties; Merr., Enum. Born. Flow. Pl. (1921) 288; Ridley, Fl. Mal. Penins. 1 (1922) 679; Backer & Bakh. f., Fl. Java 1 (1964) 516. — Type: *Commerson s.n.*, Java.

Rubus lobbianus Hook., Icon. Pl. 8 (1848) pl. 741/742. — *Rubus moluccanus* L. var. *lobbianus* (Hook.) Kuntze, Rev. Gen. Pl. 1 (1891) 222. — Type: *Lobb 62*, Java.

Rubus blumei Focke, Bibl. Bot. 72 (1910) 60. — Type: *Korthals s.n.*, Java.

Rubus magnibracteatus Ridley, J. Fed. Malay St. Mus. 8 (1917) 32. — Type: *Robinson & Kloss s.n.*, Sumatra.

Rubus elongatus J.E. Smith var. *laevicalyx* Ridley, J. Fed. Malay St. Mus. 8 (1917) 31. — Type: *Robinson & Kloss 143*, Sumatra.

Climbing, scrambling, or creeping shrubs. *Stems* up to 25 m long, woody, thick, bark dark-brown to black, densely hairy to almost glabrous, prickles few to many, short, straight. *Leaves* ovate, entire or shallowly lobed, 7.5–15 by 5–9.5 cm, base deeply cordate to truncate (in smaller leaves), margins serrate to dentate, apex acute, firmly herbaceous, nervation pedate with 8–11 pairs of nerves, venation transverse, densely hairy on nerves and veins to almost glabrous above, with a dense mat of short, curly hairs below, especially on nerves and veins covered by longer, semi-appressed hairs, distinctly two-coloured in living as well as in dried state. *Petiole* 2.5–5.5 cm long. *Stipules* early deciduous, suborbicular to elliptic in outline, 6–9 by 6–10 mm, pinnatipartite with 5–9 pairs of lobes, hairy outside. *Inflorescence* a compound raceme, 12–35 cm long, with 6–18 side branches, the lower ones in axils of leaves, up to 10 cm long, laterals usually branched again, with up to 25 flowers. *Bracts* lobed. *Pedicels* up to 3 mm long, densely to slightly hairy as are all axes, with 2 bracteoles halfway. *Flowers* unisexual, plants dioecious, flower buds globular. *Hypanthium* cup- to saucer-shaped, 3.5–5 mm across, densely tomentellous and with longer, appressed hairs outside. *Sepals* triangular to (broadly) ovate, 3–6 by 2.2–3.5 mm, apex acute or rounded and shortly apiculate, margins entire, red to purple as are hypanthium, pedicels, and bracts, indumentum outside as hypanthium. *Petals* obcor-

date to obovate, 5–11 by 4–6 mm, apex rounded or emarginate, white to pink. *Stamens* 80–125, glabrous, filaments 2–2.5 mm, anthers 0.8–1.2 mm long, staminodes 60–90, minute. *Pistils* 45–70, ovaries glabrous, on elevated, hairy torus, style c. 2 mm long, pistillobes c. 1 mm. *Collective fruits* globose, 6–10 mm diam when dry, sepals closing after anthesis, spreading under ripe fruit. *Fruits* sickle-shaped, 2–3.5 mm long, black when ripe, mesocarp a rather thin layer when dry.

Distribution – Sumatra, Malaya, Borneo, W Java, N Celebes, ? Moluccas (Tidore).

Habitat – Forests, thickets, near rivers and roads, 300–2300 m altitude.

Note – Field observations on the sex ratio are wanting. Almost 80% of the existing herbarium collections has female flowers. This may, however, not reflect the real situation but the inclination of collectors to pick fruiting specimens. See also *P. luzoniensis*.

32. *Rubus glomeratus* Blume, Bijdr. (1826) 1111; Miq., Fl. Ind. Bat. I, 1 (1855) 381; Koord., Exk. Flora Java 2 (1912) 324. — *Rubus moluccanus* L. var. *glomeratus* (Blume) Backer, Schoolfl. Java (1911) 458; Backer & Bakh. f., Fl. Java 1 (1964) 517. — Non Hook. f., Fl. Brit. India 2 (1878) 328 et auctt. al. — Type: *Blume s.n.*, Java (L, sheet nr 905.130-133/134).

Rubus glabriusculus Hassk., Flora 27 (1844) 586; Miq., Fl. Ind. Bat. I, 1 (1855) 383. — *Rubus moluccanus* L. var. *glabriusculus* (Hassk.) Kuntze, Rev. Gen. Pl. 1 (1891) 222. — Type: not indicated.

Rubus sundaicus auct. non Blume: Kuntze, Meth. Speciesbeschr. (1879) 60, 76.

Rubus ledermannii Focke, Bot. Jahrb. 56 (1916) 79; P. van Royen, Phan. Mon. 2 (1969) 91, f. 23. — Type: *Ledermann 11651* (lost), neo *van Royen NGF 30159*, New Guinea.

Rubus robinsonii Ridley, J. Fed. Mal. St. Mus. 8 (1917) 31. — Type: *Robinson & Kloss 132* (?), Sumatra.

Rubus ledermannii Focke var. *beleensis* P. van Royen, Phan. Mon. 2 (1969) 93, f. 24. — Type: *Brass 11035*, New Guinea.

Climbing, trailing, or scrambling shrubs, up to 3 m high. *Stems* sparsely to densely hairy with curly hairs never forming a closed felt, and with longer, thicker, straight hairs, glabrate and then dark brown to blackish, prickles usually few, weak. *Stipular cataphylls* at the base of lateral branches. *Leaves* broadly ovate, 4–15 by 3.5–13

cm, shallowly 3(–5)-lobed or almost unlobed, base cordate to (upper leaves) truncate, margins serrate, apex acute, coriaceous, nervation pedate with 5–7 pairs of nerves, venation reticulate, upper surface sometimes slightly bullate between nerves and veins, hairy and glabrescent, lower surface with on nerves and veins short, curly hairs that never form a closed felt, and with longer and thicker, straight hairs. *Petiole* 1–5(–7) cm long. *Stipules* early deciduous, elliptic, 7–20 by 5–10 mm, dentate to pinnatipartite with up to 6 pairs of teeth or lobes, hairy outside. *Inflorescence* a terminal thyrse with up to 6 lateral cymes of up to 3 flowers, up to 10 cm long, peduncle up to 5(–7) cm. *Bracts* pinnatipartite. *Pedicels* up to 5(–10) mm long, hairy as are the other axes. *Flowers* bisexual, flower buds ovoid, pointed. *Hypanthium* cupular, 4–7 mm across, densely woolly outside and with long, straight hairs, rarely with short, stalked glands. *Sepals* triangular, outer ones 6–9 by 4–7 mm, inner ones narrower, apex sharply pointed, not-covered margins with 2–6 teeth of 2–3 mm, covered margins entire, indumentum outside as hypanthium. *Petals* early deciduous, suborbicular to obovate or obcordate, 4.5–10 by 3–8 mm, apex rounded or emarginate, white, sometimes hairy outside. *Stamens* 24–120, in New Guinea up to 60, filaments up to 6 mm long, glabrous, rarely hairy, anthers 0.5–1 mm long, glabrous or with 1–5 hairs on the top. *Pistils* 30–60, ovaries glabrous, on elevated, hairy torus, style up to 6 mm long. *Collective fruits* globular, up to 8 mm diam., sepals closing after anthesis and staying erect around ripe fruits. *Fruits* curved, 2–4 mm long when dry, orange-red to red, mesocarp juicy, a thin membranous layer when dry.

Distribution — Sumatra, Malaya, Java, S Celebes, New Guinea, New Britain.

Habitat — Secondary and disturbed forests, and in open places like clearings, riverbanks, landslides, roadsides, forest edges, shrubland. Altitude (1200–) 1600–3000 m.

Notes — Specimens from Java and Sumatra differ slightly from the New Guinean specimens (*R. ledermannii*). Omitting overlapping measurements of flower parts, the differences are as follows. Java and Sumatra: stamens 75–120, anthers glabrous; New Guinea: stamens 24–60, anthers usually with 1–2(–5) hairs on top, rarely glabrous. The material from Celebes resembles the West Malaysian specimens. To recognize a separate species for the New Guinean plants seems not to be justified.

The Malayan specimens are also slightly different and were earlier recognized as var. *gracilis* King, J. As. Soc. Beng. 66, ii (1897) 295.

Records from Moluccas and Philippines (*R. van-overberghii* Merr., var. *pileanus* Focke) could not be substantiated but are not necessarily incorrect. See Kalkman, Blumea 29 (1984) 380, note 5.

Rubus glomeratus has often been confused with *R. moluccanus* and the two were united by some authors. However, they can be separated without difficulty by means of the leaf indumentum: the felt of thin, short, curly hairs is in the former species never entirely closed and the leaf surface remains visible, which is not the case in *R. moluccanus*.

33. *Rubus heterosepalus* Merr., Philipp. J. Sc. 20 (1922) 387; Enum. Philipp. Flow. Pl. 2 (1923) 228. — Type: *Ramos & Edaño BS 37609*, Mt Polis.

Climbing or straggling shrubs. *Stems* densely hairy with many long, straight hairs and few short, thin, curly ones, prickles up to 2 mm. *Leaves* broadly ovate, 8.5–14 by 6.5–10 cm, shallowly 3–5-lobed, base cordate, margins rather grossly serrate, apex gradually acuminate, coriaceous, nervation pedate with 5–6 pairs of nerves, venation reticulate, upper surface bullate between the veins, both surfaces with long hairs on nerves and veins and lower surface also with a dense felt of thin curly hairs all over, two-coloured when dry. *Petiole* 3–5 cm long. *Stipules* pinnatipartite with 6–8 pairs of lobes, c. 15 by 11 mm, hairy outside. *Inflorescence* a compound raceme, large and rich, 10–25 cm long, only the lowermost of the 4–6 side branches in the axil of a leaf or all laterals in the axils of bracts. *Bracts* persistent, pinnatisect, large. *Pedicels* up to c. 8 mm long, densely hairy as are the other axes. *Flowers* bisexual, flower buds ovoid. *Hypanthium* cup-shaped, c. 8 mm across, densely hairy outside. *Sepals* distinctly dimorphous, outer ones 10–14(–18) by 10–13 mm, with 5 or more pairs of lobes, those up to 7 by 1.5 mm, inner sepals triangular and not lobed, 10–11 by c. 4 mm, indumentum outside as hypanthium. *Petals* falling early, c. 6 by 3–3.5 mm, apex deeply emarginate. *Stamens* 70–90, filaments up to 4 mm, glabrous, anthers c. 0.8 mm long. *Pistils* many, ovaries glabrous, on hairy torus, style up to 4.5 mm long. *Collective fruits* probably globular, c. 1 cm diam. (dry), sepals closing after anthesis, widely spreading under ripe fruits. *Fruits* 3 mm long, mesocarp rather thick.

Distribution — Luzon.

Habitat — Mossy forest at 1800 m, according to Merrill (l.c., 1922).

Note — Only few specimens known. Related to *R. chrysophyllus*, but sepals larger, with longer lobes.

34. *Rubus keleterios* P. van Royen, Phan. Monogr. 2 (1969) 87, f. 22. — Type: Hoogland & Pullen 6226, Mt Hagen.

Shrubs. *Stems* densely hairy, prickles few, short. *Leaves* broadly ovate in outline, 5–7.5 by 5–6.5 cm, distinctly 3-lobed, base cordate, margins unevenly serrate, apex acute, firmly herbaceous, nervation palmate with 5 main nerves, venation reticulate, rather densely hairy above, lower surface with a dense woolly felt of short, thin, curly hairs, and with many thicker, straight, long hairs, distinctly two-coloured. *Petiole* 1.5–2.5 cm long. *Stipules* rather persistent, linear, 14–17 by 2 mm, with 2–3 narrow lobes, hairy outside. *Inflorescence* a leafy thyrse, c. 15 cm long, with c. 8 dichasial to monochasial laterals of c. 4 cm long, with up to 5 flowers. *Bracts* c. 10 mm long, deeply incised, bracteoles 2, on the pedicel, persistent as are the bracts. *Pedicels* up to 1.5 cm long, densely hairy as are the other axes. *Flowers* bisexual, flower buds ovoid. *Hypanthium* cup-shaped, 7 mm across, short-woolly and with longer hairs outside. *Sepals* triangular, 6.5–8 by 2.5–4 mm, outer ones usually with up to 3 pairs of teeth (up to 1 mm long), inner ones entire, indumentum outside as hypanthium. *Petals* persistent, ± orbicular, distinctly clawed, 5.5–7 by 3–5 mm, white. *Stamens* 85–125, filaments up to 5 mm, glabrous, anthers c. 0.5 mm long. *Pistils* c. 60, ovaries glabrous or with few hairs on top, on elevated, densely hairy torus, style up to 6 mm long. *Collective fruits* globular, c. 1 cm diam., sepals closing after anthesis. *Fruits* c. 4 mm long (dry), exocarp glabrous or with long hairs on backside in the upper half, mesocarp thick and leathery when dry, probably thick and juicy when living.

Distribution – New Guinea (only known from two collections from Papua New Guinea); a collection from Cook Distr., Queensland, Australia (Clarkson 2742) seems to be conspecific.

Habitat – Once in shrubland, once in grass swamp, 1700–1950 m alt. The Queensland collection is from 780 m altitude.

Note – Closely related to *R. moluccanus* but distinct by its leafshape (very broad and short, end lobe about half of total leaf length) and its long pedicels with persistent bracteoles.

35. *Rubus luzoniensis* Merr., Philipp. J. Sc., Suppl. 1 (1906) 195; Elmer, Leaf. Philipp. Bot. 2 (1908) 452; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 228. — Type: Merrill 4596, Mt Data.

Climbing or sprawling shrubs, gynodioecious? *Stems* up to 10 m long, densely hairy when young, prickles rather few to many, short but strong. *Leaves* (broadly) ovate to suborbicular, 5–8.5 by 4–6.5 cm, not or very shallowly lobed, base shallowly cordate or truncate, margins serrate, apex obtuse to acute, stiff-coriaceous, nervation pedate with 5–7 pairs of nerves, venation transverse, (rather) densely hairy above, lower surface densely short-woolly all over and with long, straight hairs on nerves and veins, distinctly two-coloured. *Petiole* 1–3 cm long. *Stipules* often rather persistent, linear, 12–19 by 3–4 mm, entire or minutely toothed, hairy outside. *Inflorescence* a panicle-like compound raceme, richly and widely branched and many-flowered, up to 40 cm long, up to 15 side branches, up to 18 cm long. *Bracts* rather large, persistent. *Pedicels* up to 5 mm long, densely hairy as all axes in the inflorescence. *Flowers* bisexual or female. *Hypanthium* saucer-shaped, 3–4.5 mm across, densely hairy outside. *Sepals* ovate, 5–6 by 2.5–4 mm, after anthesis growing to 8 by 6 mm, apex apiculate, margins entire or with minute teeth, on the outside with a woolly felt and the not-covered parts also with long appressed hairs. *Petals* obovate to elliptic, 5–6.5 by 2.5–4 mm, apex obtuse to emarginate, white. *Stamens* 50–100, filaments up to 4.5 mm, glabrous, anthers 0.5 mm long, staminodes with shorter filament and minute anther. *Pistils* 15–25, ovaries long hairy at the top on the backside, on a slightly elevated, long-hairy torus, style 2–3 mm long, some hairs at the base. *Collective fruits* consisting of few fruits only, sepals closing after anthesis. *Fruits* c. 3 mm long when dry, still hairy at apex, bright red, mesocarp a rather thick, tough layer when dry.

Distribution – Luzon.

Habitat – Forest and clearings, altitude 2000–2500 m.

Notes – The sex distribution is incompletely known. The great majority of the rather few herbarium collections have female flowers. The species is most closely related to *R. elongatus* and replaces that species in the Philippines.

36. *Rubus malvaceus* Focke, Bibl. Bot. 72 (1910) 81, f. 30; Thuan, Fl. Camb., Laos & Vietnam 7 (1968) 51, excl. specimens from Asian continent; Fl. Thailand 2 (1970) 56, idem. — *Rubus moluccanus* L. var. *malvaceus* (Focke) Backer, Schoolfl. Java (1911) 458; Backer & Bakh. f., Fl. Java 1 (1964) 517. — Type: Ploem 19980, Sindanglaya, W Java.

Rubus wichurae Focke, Btbl. Bot. 72 (1910) 79.
— Type *Wichura* 2092, Mt Tangkubanperahu,
W Java.

Shrubs with overhanging branches. *Stems* with a dense, long persistent indumentum, prickles not many, curved, up to 3 mm. *Leaves* broadly ovate to suborbicular in outline, 7–15(–19) by 7–15(–17) cm, distinctly 5- to 7-lobed, base deeply and sharply cordate, margin rather evenly serrate, apex usually acute, coriaceous, nervation 5-palmate, the lowermost main nerves pedately nerved, venation reticulate, nerves and veins impressed above and surface distinctly bullate between them, densely hairy above, lower surface with a dense felt of long, curly hairs all over and with many long, patent hairs on nerves and veins, distinctly two-coloured. *Petiole* 1.5–6(–8) cm long. *Stipules* rather persistent, pinnatifid to digitate-pinnate, 15–18 by 12–18 mm, the lobes 0.5–1.5 mm wide, hairy outside and on margins. *Inflorescence* a large thyse, 20–25 cm long, with up to 12 cymose laterals in the axils of normal or smaller leaves or bracts, the laterals up to 3 cm long, with 2–4(–10) flowers. *Bracts* pinnatifid, large. *Pedicels* up to 1 cm long, hairy. *Flowers* bisexual, the flower buds ovoid. *Hypanthium* cupular, 6–10 mm across, densely hairy outside. *Sepals* recurved at the top during anthesis, triangular, 7–10 mm long, outer ones 4–8 mm wide, the not-covered margins long-dentate, inner ones 3.5–6 mm wide, entire, indumentum outside as hypanthium. *Petals* suborbicular, 5–6 by 5–5.5 mm, clawed, the margin undulating, white. *Stamens* 100–200, filaments up to 5 mm, glabrous, anthers 0.5–0.8 mm long, with long hairs on top. *Pistils* 60–80, ovary glabrous, the style up to 7.5 mm long. *Collective fruits* not seen. *Fruits* 2–3 mm long, the colour unknown.

Distribution — W Java, Sumba.

Habitat — Hardly any data, one collection from 1300 m altitude.

Notes — Quite closely related to *R. rugosus* J.E. Smith, which is known from the Asian continent and Sri Lanka. It seems, however, premature, to combine the two.

The patchy distribution cannot be explained by supposing an escape from the botanical garden at Cibodas, Java.

37. *Rubus mearnsii* Elmer, Leafl. Philipp. Bot. 2 (1908) 448; Merr., Philipp. J. Sc., Bot. 5 (1910) 353; Enum. Philipp. Flow. Pl. 2 (1923) 228. — Type: *Mearns* BS 4304, Luzon.

Shrubs. *Stems* rather densely hairy when young and with many c. 1 mm long gland-bearing hairs, prickles (rather) many, curved, up to 1.5 mm. *Leaves* broadly ovate to suborbicular, 5–9 by 5–7 cm, not or faintly lobed, base cordate, margin rather coarsely serrate, apex obtuse to acute, coriaceous to herbaceous, nervation pedate with 6–7 pairs of nerves, venation transverse, both surfaces rather sparsely hairy, more densely on midrib and nerves below. *Petiole* 1–2 cm long. *Stipules* persistent, tongue-shaped, 7–9 by 3–4 mm, with 5–6 pairs of small teeth, hairy and glandular outside. *Inflorescence* a thyse, laxly paniculate in appearance, up to 52 cm long, with up to 18 lateral branches of up to 24 cm long and with up to 30 flowers. *Bracts* up to 9 mm long, hairy and glandular outside. *Pedicels* 0.5–1.5 cm long, long-hairy and with glandular hairs, as are the other axes. *Flowers* bisexual, flower buds ovoid, pointed. *Hypanthium* saucer-shaped, 6 mm across, hairy and glandular-hairy outside. *Sepals* ovate, 7–8 mm long, outer ones 5–6 mm wide, with 3–6 teeth on the uncovered margins, inner ones c. 4 mm wide, entire, indumentum outside as hypanthium. *Petals* none. *Stamens* 60–90, filaments up to 5 mm, glabrous, anthers 0.5–0.8 mm long. *Pistils* 12–18, ovaries glabrous, on flat, hairy torus, style up to 4 mm long. *Collective fruits* c. 6 mm diam., loose, often only some of the fruits developing, sepals closing and remaining closed after anthesis. *Fruits* 4 mm long when dry, mesocarp fleshy, a rather tough layer when dry.

Distribution — Luzon.

Habitat — Only six collections investigated, the majority without field data. According to Merrill (1923) in mossy forest, c. 2400 m altitude, one specimen collected along the road at c. 2260 m.

Note — Closely related to *R. benguetensis*.

38. *Rubus moluccanus* L., Spec. Pl. (1753) 1197; Blume, Bijdr. (1826) 1109; Miq., Fl. Ind. Bat. I, 1 (1855) 382; Backer & Bakh. f., Fl. Java I (1964) 516, excl. var. *glomeratus* (Blume) Backer and var. *malvaceus* (Focke) Backer; P. van Royen, Phan. Monogr. 2 (1969) 98, incl. var. *austropacificus* P. van Royen and var. *thespesiaephyllus* P. van Royen. — Type: Rumphius, Herb. Amboin. 5 (1747) 88, pl. 47, f. 2 [*Rubus moluccus latifolius*].

Rubus sundaicus Blume var. *discolor* Blume, Bijdr. (1826) 1111. — *Rubus moluccanus* L. var. *discolor* (Blume) Kalkman, Blumea 29 (1984) 359. — Type: Kuhl & van Hasselt s.n., Java.

Rubus hasskarlii Miq., Fl. Ind. Bat. I, 1 (1855) 381. — *Rubus moluccanus* L. var. *hasskarlii* (Miq.) Kuntze, Rev. Gen. Pl. 1 (1891) 222. — Type: not identified, Java.

Rubus moluccanus L. var. *obtusangulus* Miq., Fl. Ind. Bat. I, 1 (1855) 383, 'obtusangula'; Kalkman, Blumea 29 (1984) 362. — Type: *Junghuhn s.n.*, Java.

Rubus angulosus Focke, Bibl. Bot. 72 (1910) 90, f. 35, nom. illeg., non Gremli (1871); Koord., Exk. Fl. Java 2 (1912) 324; Ridley, Fl. Mal. Penins. 1 (1922) 678, f. 59. — *Rubus moluccanus* L. var. *angulosus* Kalkman, Blumea 29 (1984) 364 — *Kurz (Amann) s.n.*, Bangka, lecto.

Rubus hasskarlii Miq. subsp. *dendrocharis* Focke, Bibl. Bot. 72 (1910) 99, f. 42. — *Rubus dendrocharis* (Focke) Focke, Bot. Jahrb. 54 (1916) 70. — *Rubus moluccanus* L. var. *dendrocharis* (Focke) P. van Royen, Phan. Monogr. 2 (1969) 106, f. 28. — Type: *Rodatz & Klink 182*, New Guinea, in SING.

Rubus glomeratus auct. non Blume: Ridley, Fl. Mal. Penins. 1 (1922) 679.

For a more complete synonymy, see Kalkman, Blumea 29 (1984) 346.

Climbing or scrambling, rarely creeping shrubs. *Stems* up to 6(–10) m long, densely hairy when young, (tardily) glabrescent, prickles usually not many, small. *Leaves* ovate to broadly ovate in outline, 6–20 by 4–15 cm, variously lobed, base cordate to subtruncate, margins serrate, apex acute to acuminate, (firm)-herbaceous, nervation pedate with 5–9 pairs of nerves or palmate with 7 main nerves (var. *angulosus*), venation (widely) reticulate, the surface between the veins not or indistinctly raised above, upper surface hairy, especially on the nerves, lower surface with a densely woven felt of long, thin, curly hairs all over, and with on nerves and veins usually many long, thicker, straight, appressed to patent hairs, distinctly two-coloured. *Petiole* 2–6 cm long. *Stipules* early falling, 7–17 by 4–12 mm, pinnatilobed to pinnatipartite with 4–10 pairs of lobes, sometimes digitate, lobes up to 8 by 1 mm, hairy outside. *Inflorescence* a terminal, leafy, compound raceme, up to 20(–50) cm long, with up to 12 laterals, those up to 5(–9) cm long and with up to 10(–30) flowers. *Bracts* up to 17 by 9 mm. *Pedicels* up to 1 cm long, hairy as are all axes. *Flowers* bisexual, flower buds ovoid, pointed. *Hypanthium* cupular, 4–7 mm across, densely woolly and with patent to appressed straight hairs outside. *Sepals* erect or apically recurved in anthesis, triangular to ovate, 4–9 by 2–6 mm,

apex acute to pointed, not-covered margins of the outer sepals with one or few, up to 3 mm long teeth, covered margins entire, indumentum outside as hypanthium. *Petals* long remaining, suborbicular to elliptic, 3–7 by 3–6 mm, apex rounded to emarginate, white, rarely reported to be pink, red, or yellow. *Stamens* 30–185, filaments up to c. 4 mm, anthers 0.2–0.7 mm long, mostly with few to several long hairs on top or on connective. *Pistils* 30–135, ovaries glabrous, on elevated, hairy or glabrous torus, styles up to 9 mm long. *Collective fruits* globular, 0.8–1 cm diam. when dry, sepals closing or apically slightly recurved after anthesis, spreading at ripeness. *Fruits* 2–3 by 1–2 mm when dry, red, mesocarp thick and fleshy, only a thin layer when dry. — **Figs. 5, 6.**

Distribution — All over Malesia, extending to the North to Sri Lanka (introduced?), Thailand, and Vietnam, to the South and East to Queensland, Carolines, New Hebrides, Fiji, and New Caledonia.

Habitat — Essentially at low and medium altitudes, up to 2000 m, occasionally higher.

Uses — Information from herbarium labels is reported under the varieties. According to literature [Burkill, Dict. Econ. Prod. Mal. Penins. (1966) 1952; Heyne, Nutt. Pl. Indon. (1950) 693; Quisumbing, Medic. Pl. Philipp. (1951) 354; Woodley (ed.), Medic. Pl. Papua New Guinea I, Morobe Prov. (1991) 120] the species has a number of widespread medicinal uses. The sap of shoots, the chewed leaves or decoctions of roots are obviously effective in relieving internal pains, in the treatment of dysentery or diarrhoea, sprue and angina, and for external afflictions like sores and boils. Several times the use as an emmenagogue (stimulating menstruation) or abortifacient is mentioned, but also applications to prevent miscarriage, which seems a strange combination. Use of the fruits as a remedy for children's bed-wetting was mentioned by Rumphius and later often repeated. It is possible that the medicinal uses recorded for this species also are valid for other species of the genus.

Notes — *Rubus moluccanus* L. is taken here in the narrowest possible sense. See Kalkman, Blumea 29 (1984) 349, for a discussion on the species limits as observed by Kuntze [Meth. Speciesbeschr. (1879) 33, and Rev. Gen. Pl. 1 (1891) 222] and Focke [Bibl. Bot. 72 (1910) 88]. *Rubus moluccanus* has been considered by Backer [Schoolfl. Java (1911) 457, and later] and by others as a taxonomical problem of the same order as presented by *R. fruticosus*, but incorrectly so. *Rubus moluccanus* is, if properly delimited from neighbouring but recognizable species, not much more variable than any other widely distributed species. There is no

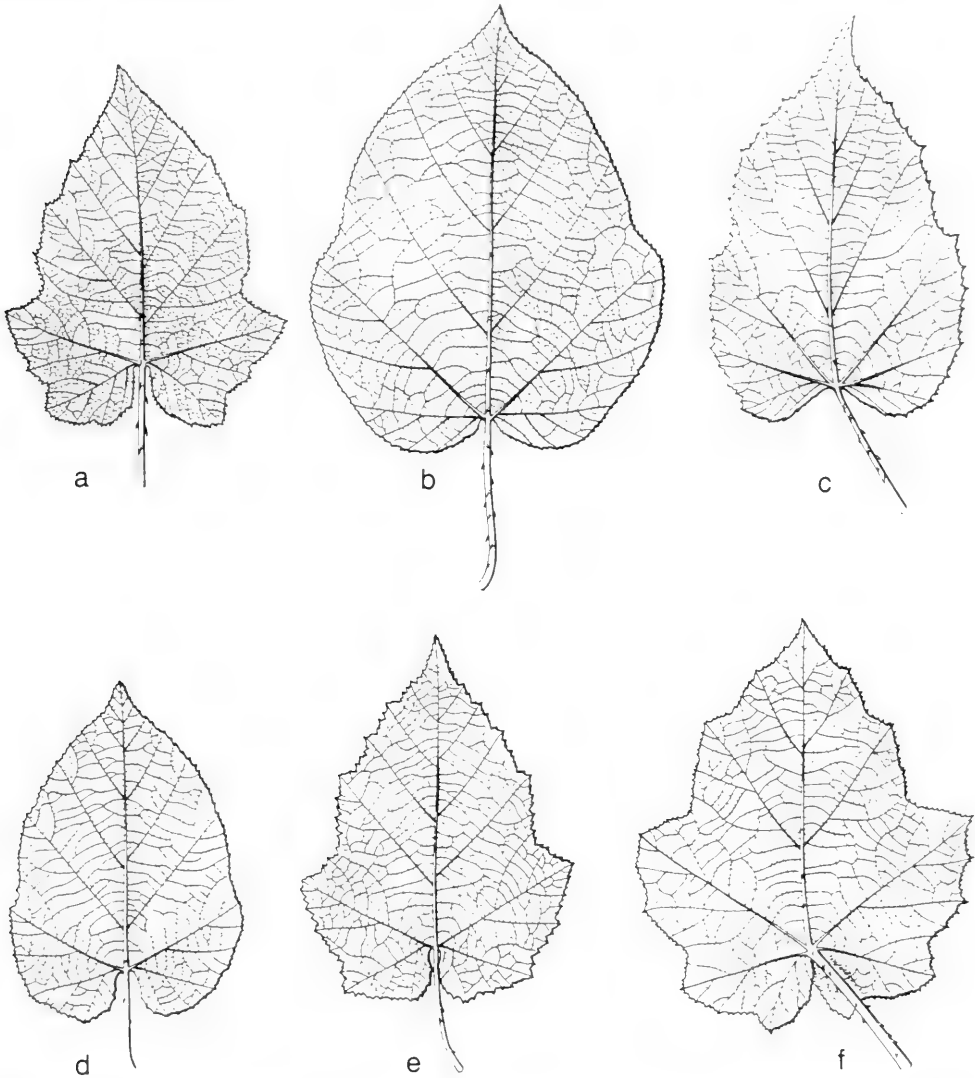


Fig. 5. *Rubus moluccanus* L. Leaf shapes of the varieties: a, b. var. *moluccanus*; c. var. *obtusangulus* Miq.; d, e. var. *discolor* (Blume) Kalkman; f. var. *angulosus* Kalkman.

evidence at present for supposing that the species is apogamous.

The species was divided by Kalkman into four varieties, based on leaf characters. Intermediates do occur and inadequately collected material showing – as too often is the case – only the upper leaves of lateral branches, cannot always be identified down to the variety.

KEY TO THE VARIETIES

- 1a. Leaf-base subtruncate to shallowly cordate, the basal lobes making an obtuse angle. The straight hairs on nerves and veins below appressed **d. var. obtusangulus**
- b. Leaf-base cordate, the angle between the margins of the basal lobes sharp 2

- 2a. The straight hairs on nerves and veins below appressed to semi-appressed

b. var. *discolor*

- b. The straight hairs on nerves and veins below patent 3
3a. The basal lobes of the leaves distinctly overlapping or at least touching each other. Leaves 3–5(–7)-lobed, the lateral incisions up to 2 cm deep, the nervation 7-palmate to -pedate

a. var. *angulosus*

- b. The basal lobes of the leaves not overlapping, their margins parallel or making a sharp angle. Leaves not lobed or shallowly 3–5-lobed, the lateral incisions 0.5–1 cm deep, the nervation 5- or 7-pedate **c. var. *moluccanus***

a. var. *angulosus* Kalkman, *Blumea* 29 (1984) 364. See there for synonymy.

Young twigs and nerves and veins on the lower leaf surface with semi-appressed to patent, long, straight hairs over the woolly felt of thin, curly hairs. *Leaves* distinctly 3–5(–7)-lobed with the main lobes usually shallowly lobed again, apical lobe large (half of the total leaf length or slightly smaller), length/width index (1.1–)1.2–1.3(–1.4), base cordate, the margins of the basal lobes distinctly overlapping or at least touching each other. *Stamens* (85–)100–185, anthers hairy on apex. – **Fig. 5f.**

Distribution – Thailand, Vietnam, Andaman Is., Nicobar Is.; **Malesia**: Sumatra and islands near it, Malaya, Singapore, Java, Borneo, Palawan, Celebes, Lesser Sunda Islands.

Habitat – Forest edges, secondary forest, thickets, also near the beach and on riverbanks, altitude 0–500(–1000) m, the few specimens seen from Java from higher altitude (up to 1450 m).

Uses – Fruits edible. Boiled roots are a medicine against dysentery (Malaya, *Alvins* 375).

b. var. *discolor* (Blume) Kalkman, *Blumea* 29 (1984) 359. See there for synonymy.

Young twigs and nerves and veins on lower leaf-surface with appressed (rarely semi-appressed) straight hairs over the woolly cover of curly hairs. *Leaves* shallowly 3–5-lobed, sometimes hardly lobed, rarely more distinctly lobed, length/width index (1.0–)1.2–1.5(–2.5), basal incision narrow with subparallel margins or a sharp angle between them, the leaves in and close under the inflorescence often with a wider angle or base even subtruncate. *Stamens* 70–180, anthers hairy at apex or glabrous. – **Fig. 5d, e.**

Distribution – **Malesia**: Sumatra, Malaya (Pahang, Penang I., and Tioman I.), Borneo, Java, Philippines, Celebes incl. Buton I., Lesser Sunda Islands, Moluccas, New Guinea, Bismarck Archipelago. Also in Solomon Islands, New Hebrides (Erromanga), and New Caledonia.

Habitat – Secondary and shrubby vegetation, in primary forest especially in clearings, along paths and in the forest margin, but possibly also in closed forest, further on hillsides, roadsides, riversides, from sea-level up to 2000 m altitude, highest records c. 2500 m and (once) 2900 m.

Uses – The fruits are edible but tasteless. The fluid from the stems is applied for eye diseases (Java, *Kuhl & van Hasselt*), fluid from the leaves is applied to the eyes of young mothers (Borneo, *Winckel 1013*). Young twig ends eaten raw as vegetable (Java, *Bakhuizen van den Brink 8168*).

Notes – The longer leaves with leaf index > 1.5 are found especially in Sumatra and Malaya (up to 2.0) and in New Guinea (up to 2.5).

Two specimens from Mt Panggrango on Java (*Schiffner 2019, van Steenis 17620*) have peculiar gland-bearing bristles on vegetative parts and on the hypanthium and sepals.

For distinction with var. *obtusangulus*, see there.

c. var. *moluccanus* — For synonymy, see Kalkman, *Blumea* 29 (1984) 346.

Young twigs and nerves and veins on the lower leaf-surface with (apart from the underlying woolly felt) patent to semi-patent, long, straight hairs. *Leaves* shallowly 3–5-lobed or not lobed at all, length/width index (1.0–)1.1–1.4(–1.8), basal incision narrow with parallel margins or a sharp angle between them. *Inflorescence* usually leafy but sometimes all lateral racemes in axils of bracts. *Stamens* 30–150(–200), anthers hairy at apex or glabrous. – **Fig. 5a, b.**

Distribution – Sri Lanka [introduced according to Tirvengadam, *Fl. Ceyl.* 3 (1981) 353], Thailand, Vietnam; **Malesia**: Sumatra, Malaya incl. Penang I. and Langkawi I., Singapore, Borneo, Java, Philippines, Celebes, Lesser Sunda Islands, Moluccas, New Guinea, New Britain. Also in the Solomon Islands, Carolines, Fiji Islands, and Australia (Queensland).

Habitat – Forest edges, secondary forest, lighter places in primary forest (e.g. riverbanks), open places like thickets, roadsides, lavastreams, heath vegetation, from sea-level up to c. 2000 m, very rarely higher.

Uses – The fruits are edible but have a poor flavour according to several collectors. Young, fresh

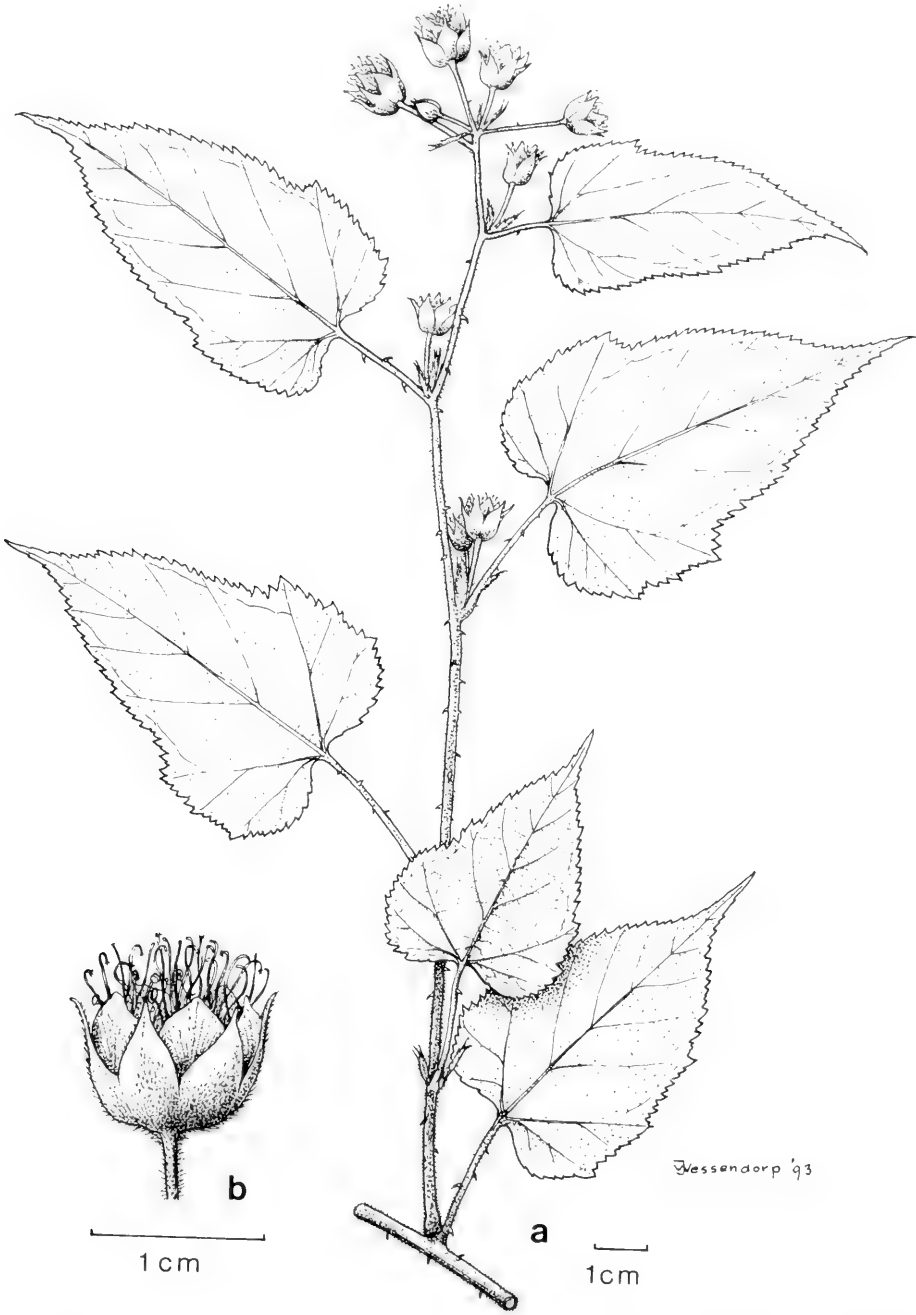


Fig. 6. *Rubus moluccanus* L. var. *obtusangulus* Miq. a. Flowering branch; b. old flower (a: Schodde 1493; b: Streimann NGF 34081).

leaves are a cure for diarrhoea (Borneo, *Mamit* S 33363). Twigs may be used for bundling firewood (Philippines, *Conklin & Buwaya* PNH 78635) and are used for catching bats (Philippines, *Britton* 434, how is not described).

d. var. *obtusangulus* Miq., Fl. Ind. Bat. I, 1 (1855) 383; Kalkman, *Blumea* 29 (1984) 362. See there for synonymy.

Young twigs and nerves and veins on the lower leaf surface with appressed (sometimes semi-appressed), long, straight hairs over the woolly layer of curly hairs, the straight hairs sometimes only sparsely present. *Leaves* shallowly 3–5-lobed to hardly lobed at all, length/width index (1.1–)1.3–1.7(–1.9), base subtruncate to shallowly cordate with an obtuse angle between the margins of the basal lobes. *Stamens* 30–140, anthers nearly always hairy on top, but in Sumatra always glabrous. – **Figs. 5c, 6.**

Distribution – Burma, Thailand, Vietnam; *Malesia*: Sumatra, Malaya, Borneo, Java, Philippines, New Guinea, New Britain.

Habitat – Forest edges, secondary forest, thickets, along roads, trails, and streams, altitude (150–)900–2000(–3000) m.

Uses – The fruits are edible. Stems are used as binding material (Philippines, *Conklin & Buwaya* PNH 80574). Men wash their bodies with the leaves before going to fight (Papua New Guinea, Maprik Subprov., *Wiakabu* LAE 73551).

Note – The recognition in the herbarium of the varieties *discolor* and *obtusangulus* does usually not present a problem, if the specimen possesses a number of leaves below the inflorescence. If only the flowering part of a twig is present, identification is not reliably possible since the raceme-bearing leaves of var. *discolor* are often subtruncate at the base.

39. *Rubus perfulvus* Merr., Philipp. J. Sc. 20 (1922) 386; Enum. Philipp. Flow. Pl. 2 (1923) 229. — Type: *Ramos & Edaño* BS 38566, Mindanao.

Climbing shrubs. *Stems* densely hairy when young, prickles few, short. *Leaves* ovate, 5–9 by 4–7 cm, not or hardly lobed, base truncate to rounded, margin grossly dentate, apex acuminate, stiff coriaceous, 3-nerved, the two lateral main nerves with c. 4 basiscopic side-nerves, the middle nerve with c. 4 pairs of lateral nerves, nerves and veins impressed above and leaf surface bullate, upper surface scattered long-hairy, glabrescent, lower

surface with a dense and thick woolly felt of curly hairs and with longer, straight, appressed hairs on nerves and veins, distinctly two-coloured. *Petiole* 1–1.5 cm long. *Stipules* persistent, up to 15 by 3 mm, entire. *Inflorescence* according to Merrill a terminal, 5-flowered, compact raceme and also some solitary flowers in the upper leaf axils. *Flowers* large. *Sepals* triangular, c. 12 by 3–4 mm, outer ones with few marginal teeth. *Petals* not seen. *Stamens* probably with glabrous anthers. *Collective fruits* c. 1.2 cm diameter. *Fruits* glabrous (Merrill), red, the mesocarp a thin membranous layer when dry, endocarp rugose, stone c. 3 mm long.

Distribution – Only known from the type specimen from Mt Lipa.

Habitat – Mossy forest, c. 2000 m altitude.

Note – Insufficiently known, complete inflorescences and flowers in anthesis not seen. Relationship is probably closest to *R. rolfei* Vidal.

40. *Rubus pyrifolius* J.E. Smith, Pl. Icon. Hact. Ined. 3 (1791) t. 61; Miq., Fl. Ind. Bat. I, 1 (1855) 384; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 229; Backer & Bakh. f., Fl. Java 1 (1964) 516; Steenis, Mount. Fl. Java (1972) pl. 45–6. — *Dalibarda pyrifolia* (J.E. Smith) Blume, Bijdr. (1826) 1112. — *Rubus molucanus* L. var. *pyrifolius* (J.E. Smith) Kuntze, Rev. Gen. Pl. 1 (1891) 222. — Type: *Commerçon s.n.*, Java.

Dalibarda laifolia Blume, Bijdr. (1826) 1112. — Type: not found, from Cianjur, W Java.

Rubus philippinensis Focke in Elmer & Focke, Leaf. Philipp. Bot. 5 (1913) 1617; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 229. — Type: *Elmer* 13606, Mindanao.

For a more complete synonymy, see Kalkman, *Blumea* 29 (1984) 333.

Climbing shrubs. *Stems* up to 8(–30) m long, usually with few hairs, prickles usually few, small, minute capitate brown hairs often present on vegetative parts and inflorescences. *Leaves* elliptic to ovate, 6.5–16 by (2.5–)3.5–8.5(–9.5) cm, not lobed, base rounded, margin serrate-crenate, apex acute or obtuse and then shortly or long acuminate, herbaceous, nervation pinnate with 5–8 pairs of nerves, the lowermost of these with up to 6 strong, basiscopic side nerves, rarely truly pedate, secondary nerves not reaching the margin, venation widely transverse, usually rather densely hairy on midrib and larger nerves above, lower surface with (semi-)appressed hairs on nerves and veins. *Petiole* 0.5–1(–3) cm long. *Stipules* early

falling, 6–9 by 0.5–1.2 mm, apically 3–6-lobed, lobes up to 6 mm, hairy. *Inflorescence* broadly paniculate, a leafy compound raceme, up to 30 (–40) cm, with 9–16 primary laterals, the latter up to 12 (–15) cm, with up to 10 side branches, usually being dichasia with up to 7 flowers. *Bracts* up to 9 by 1.5–2 mm, lobed. *Pedicels* 6–8 (–10) mm long, densely hairy as are the other axes in the inflorescence. *Flowers* bisexual, flower buds ovoid, pointed. *Hypanthium* saucer- to cup-shaped, 3–5 mm across, shortly woolly outside, sometimes also with appressed, straight hairs. *Sepals* triangular to ovate, reflexed to horizontal during anthesis, 4–7 (–11) by 2–4 mm, outer margins with 1 or 2 teeth or lobes of up to 2 mm, inner margins entire, indumentum outside as hypanthium. *Petals* elliptic to obovate, 2–5 (–7) by 0.5–2 (–3.5) mm, apex (sub)truncate, usually sinuate or notched, white. *Stamens* (40–)50–80 (–100), filaments up to 6.5 mm, anthers 0.5–0.8 mm long, usually wider than long, violet. *Pistils* (3–)5–10 (–17), ovaries usually with many long hairs on the dorsal side, rarely glabrous, on a low, long-hairy torus, styles up to 5.5 (–7) mm long, rarely with some hairs in basal part. *Collective fruits* loose, usually less than half of the ovaries developing, c. 0.5 cm diam., sepals closing after anthesis. *Fruits* 3.5–4.5 mm long when dry, with some hairs, red, mesocarp rather thick and fleshy.

Distribution — Laos, S Vietnam, Thailand, China; *Malesia*: Sumatra, Borneo, Java, Philippines (Negros, Leyte, Mindanao), Celebes, Lesser Sunda Islands (Bali, Lombok, Flores).

Habitat — Forest and forest edges, altitude 500–1700 (–2200) m.

Ecology — Characteristic leaf galls, caused by a gall-mite, are found in specimens from Java and Sumatra. The galls are hollow bladders on the upper leaf surface, purple coloured according to Docters van Leeuwen & Docters Van Leeuwen-Reynvaan, *Zoöecidia* of Neth. Indies (1926) 219. On the underside of the leaf the bladders are densely hairy.

41. *Rubus rolfei* Vidal, Phan. Cuming. (1885) 171; Elmer, *Leaf. Philipp. Bot.* 2 (1908) 454; Merr., *Enum. Philipp. Flow. Pl.* 2 (1923) 230. — Types: *Cuming 808*, lecto; *Vidal 294*; both Luzon.

Rubus elmeri Focke, *Bibl. Bot.* 72 (1910) 112; Merr., *Enum. Philipp. Flow. Pl.* 2 (1923) 227. — Types: *Merrill BS 4651*, *Mearns BS 4305*, Luzon.

Rubus calycinoides Hayata, *Icon. Pl. Form.* 3 (1913) 88, non Kuntze (1879). — Type: *Mori & Kato s.n.*, Taiwan.

Sprawling shrubs with prostrate long shoots up to 1 or more m, and with axillary, ascending, leafy shoots up to 25 cm long, terminating in an inflorescence, more rarely climbing shrubs. *Stems* densely hairy when young, prickles (very) few, small. *Leaves* orbicular to triangular in outline, 2–5.5 (–9) by 2–5 (–9) cm, shallowly 3- to 5-lobed, base cordate, basal lobes rounded, margin unevenly crenate, apex rounded to acute, stiff-coriaceous, nervation pedate, with 4–5 pairs of nerves, venation widely reticulate, upper surface bullate between nerves and veins, hairy but soon glabrous above, lower surface with a dense woolly felt of thin, curly hairs, and with on nerves and veins longer, patent, straight hairs, distinctly two-coloured. *Petiole* 0.5–3 (–4.5) cm long. *Stipules* rather long persistent, 6–10 (–13) by 2.5–4 (–7) mm, incised. *Inflorescence* a terminal, simple raceme, usually very dense, up to 3 cm long, with up to 8 flowers. *Bracts* up to 13 by 10 mm, incised. *Pedicels* 0–5 mm long, densely hairy as is the rachis of the raceme. *Flowers* bisexual, flower buds ovoid. *Hypanthium* saucer-shaped, 4–6 mm across, densely woolly and with straight, longer hairs outside. *Sepals* triangular, outer ones 6–10 by 3–8 mm, inner ones narrower, growing after anthesis, apex acute to acuminate, uncovered margins with 1–3 small teeth, up to 3 mm, indumentum outside as hypanthium. *Petals* orbicular with rounded apex, up to 14 by 12 mm, white. *Stamens* 120–140, filaments up to 5 mm, anthers 0.5–1 mm long, glabrous or with few long hairs. *Pistils* 40–80, ovaries glabrous, on elevated, hairy torus, styles up to 5 (–8) mm long. *Collective fruits* globular, c. 1 cm, sepals closing after anthesis, spreading at ripeness. *Fruits* 2–2.5 mm long when dry, yellow to orange (also reported as pink or red), mesocarp soft and thick, only a thin layer when dry.

Distribution — Taiwan; *Malesia*: Philippines (Luzon, Negros, Mindoro).

Habitat — Forest and more open places like clearings at higher altitudes, alt. (900–)1500–2700 m.

Uses — The fruits are edible and sweet.

Note — Most of the plants collected had prostrate, woody twigs with erect, determinate, short laterals terminating in an inflorescence [see Kalkman, *Blumea* 29 (1984) 371, f. 5]. The last-but-one order branches, however, are not always creeping but sometimes climbing and maybe there are even bushy plants with more or less erect branches. Possibly this will be largely determined by local conditions. Herbarium specimens of creeping plants may look rather different from collections from climbing shrubs, but in essential characters except habit they are alike.

42. *Rubus smithii* Backer, Schoolfl. Java (1911) 456. — *Rubus sundaicus* auct. non Blume: Backer & Bakh.f., Fl. Java 1 (1964) 516, p.p. — Type: Backer 33873, Java, lecto.

Rubus maximus Kuntze, Meth. Speciesbeschr. (1879) 62, 76, nom. illeg., non Marsson (1869). — *Rubus moluccanus* var. *maximus* Kuntze, Rev. Gen. Pl. (1891) 222. — Type: not identified.

Climbing shrubs. *Stems* up to 10 m long, hairy, prickles few to many, 1–2 mm long, reddish. *Leaves* ovate, 7–15 by 4.5–9 cm, not or shallowly lobed, base subtruncate to cordate, margin grossly serrate, apex acute to subacuminate, sometimes obtuse, rather stiffly herbaceous, nervation pedate with 6–10 pairs of nerves, venation widely transverse, upper surface only hairy on main nerves, lower surface with scattered semi-appressed to patent hairs on nerves and veins, two-coloured. *Petiole* 1–4 cm long. *Stipules* rather persistent, 5–9 by 3–5 mm, pinnatisect to -partite with 3–5 pairs of lobes, those 2–5 by 0.2–0.5 mm. *Inflorescence* an overhanging or pendant compound raceme, 15–35 cm long, with up to 12(–15) laterals of up to 9 cm, the laterals bearing up to 7 dichasia or cymes, each with up to 5 flowers. *Bracts* stipule-like to dentate, up to 6 mm long. *Pedicels* 6–10 mm long, densely woolly as are the other axes in the inflorescence. *Flowers* functionally unisexual, plants ?dioecious, flower buds broadly ovoid. *Hypanthium* cup-shaped, 4–5 mm across, densely woolly outside and also with appressed, straight hairs. *Sepals* (broadly) ovate, 3.5–5 by 3–5 mm, apiculate just under the obtuse apex outside, margins entire, indumentum outside as hypanthium. *Petals* obovate, 7–9 by 5–6 mm, apex rounded or emarginate, white. *Stamens* 70–140, glabrous, filaments up to 3 mm, anthers 1.5–2 mm long, staminodes in female flowers 60–100, up to 1.5 mm long, with minute anther rudiment. *Pistils* 30–100, ovaries densely long-hairy on the backside or glabrous, on slightly elevated, long-hairy torus, styles 1–3 mm long, pistillodes in supposedly male flowers as pistils but smaller. *Collective fruits* globose, up to 1 cm, compact, sepals spreading under ripe fruits. *Fruits* up to 3 mm long when dry, exocarp light red (to blackish?), still hairy to glabrous, mesocarp rather thick fleshy or juicy, endocarp with broad dorsal side.

Distribution – Sumatra, W Java.

Habitat – Forest and forest edges, from sea-level to 2000 m altitude.

Note – Female flowers have obviously non-functional, small stamens but in flowers with per-

fect stamens the ovaries are not always reduced in size. Herbarium study is, therefore, not conclusive on sex distribution in this species.

43. *Rubus sorsogonensis* Elmer, Leaf. Philipp. Bot. 10 (1939) 3777. — Type: Elmer 14607, Luzon.

Climbing shrubs. *Stems* slightly hairy, prickles few, short. *Leaves* ovate, 11–12 by 6–7 cm, not lobed, base cordate, margin grossly serrate, apex acute, herbaceous, nervation pedate with 6–7 pairs of nerves, venation widely parallel, sparsely hairy above and below. *Petiole* 1–1.5 cm long. *Stipules* lanceolate, up to 11 by 3.5 mm, margins with one minute tooth, with short hairs and short glandular hairs outside. *Inflorescence* a terminal panicle, many-flowered, branches up to 12 cm, the last branchings di- or monochasial. *Bracts* up to 15 by 1.5 mm, slightly lobed. *Pedicels* 1–1.5 cm long, sometimes with stalked glands between the hairs, like in the other axes of the inflorescence. *Flowers* bisexual, flower buds ovoid, pointed, no glands on the flowers. *Hypanthium* saucer-shaped, 4 mm across. *Sepals* triangular, 10–12 by 3–4 mm, long pointed, outer ones with a minute tooth on each uncovered margin. *Petals* none. *Stamens* c. 100, glabrous, filaments up to 8 mm, anthers 0.8 mm long. *Pistils* c. 30, ovaries glabrous, styles c. 6 mm long. *Fruits* not seen.

Distribution – Only known from the type, collected in the Philippines (Luzon, on Mt Bulusan), at 450 m altitude.

Note – Related to *Rubus benguetensis*.

44. *Rubus sundaicus* Blume, Bijdr. (1826) 1111; Miq., Fl. Ind. Bat. I, 1 (1855) 383. — Type: Reinwardt s.n., Tidore (see note).

Stems appressed-cobwebby, prickles very few, very small. *Leaves* ovate, 13–15 by 9.5–11 cm, shallowly 3-lobed, base cordate, margin rather coarsely serrate-crenate, apex gradually acuminate, herbaceous, nervation pedate with 9–10 pairs of nerves, venation widely transverse, upper surface only with hairs on midrib, lower surface with remnants of cobwebby felt on nerves and veins. *Petiole* 4–6 cm long. *Stipules* not seen, scar distinct. *Inflorescence* a terminal thyse, c. 12 cm long, with 6–7 dichasial to monochasial laterals, up to 2.5 cm long, partly in the axils of leaves. *Bracts* incised from apex. *Pedicels* up to 1 cm long, hairy as are all other axes. *Flowers* bisexual, flower buds ovoid, pointed. *Hypanthium* cup-shaped, 5–6 mm across, densely woolly and with semi-appressed

longer hairs outside. *Sepals* triangular, 6.5–8 by 3.5–5 mm, long-pointed, outer ones with 2 short teeth on each uncovered margin, inner ones entire and narrower, indumentum outside as hypanthium. *Petals* 6–7 by 5 mm. *Stamens* c. 65, filaments up to 4.5 mm, glabrous, anthers 0.5–0.8 mm long, glabrous or with 1–2 long hairs on top. *Pistils* c. 30, ovaries with long hairs on the dorsal

side, on hairy torus, styles c. 3 mm long. *Fruits* not seen.

Distribution — Only known from two sheets bearing different localities, resp. Tidore (Moluccas) and Java, but probably originating from one collection made in the Moluccas.

Note — Resembling *Rubus cumingii* with which it may be related.

Subgenus *Chamaebatus*

Rubus subg. *Chamaebatus* (Focke) Focke, Bibl. Bot. 72 (1910) 17; Zandee & Kalkman, Blumea 27 (1981) 75. — *Rubus* sect. *Chamaebatus* Focke, Abh. Naturw. Ver. Bremen 4 (1874) 145, 146.

Herbaceous to slightly woody, creeping plants. *Leaves* simple, reniform to cordate, not or slightly lobed, rarely more deeply incised, nervation pedate with usually 2 or 3 main side nerves at the very base of the midrib, each with 2 or more basisopic laterals, nerves terminating in the margin. *Stipules* free, on the junction of stem and petiole, persistent. *Flowers* bisexual, solitary, terminal, more rarely 2 or 3 on erect laterals. *Hypanthium* saucer-shaped, with prickles outside. Inner *sepals* narrower than outer ones, uncovered margins pinnately lobed. *Fruits* loosely cohering, becoming loose from the elevated torus when ripe.

Distribution — Few species, with a disjunct area: America (Pacific NW America and Mexico) and Asia (India, China, Taiwan, Japan, Philippines, Java). Two species in *Malesia*.

Note — A derived group of small herbaceous plants with reduced inflorescences.

45. *Rubus calycinus* [Wall. in litt.] ex D. Don, Prod. Fl. Nepal. (1825) 235; Backer & Bakh. f., Fl. Java 1 (1964) 515; Steenis, Mount. Fl. Java (1972) pl. 46-1. — *Dalibarda calycina* (D. Don) Seringe in DC., Prod. 2 (1825) 568. — Type: Wallich, Gosaingsthan.

Rubus boschianus Zoll., Nat. Tijds. Ned. Indië 14 (1857) 175, 176. — *Rubus calycinus* D. Don forma *javanicus* Kuntze, Meth. Speciesbesch. (1879) 106, nom. nud. — *Rubus calycinus* D. Don var. *suffruticosus* Focke, Bibl. Bot. 72 (1910) 21. — Type: Zollinger 2964, Java.

Main *stems* creeping, up to 3 m long, rooting on the nodes, with erect, little or not branched laterals in the axils of leaves, all stems sparsely hairy, prickles rather few, small. *Leaves* reniform, 3–6.5 by 3.5–7 cm, usually shallowly 3–5(–7)-lobed, base deeply cordate, margin serrate, apex rounded, rather stiff and brittle when dry, nervation pedate with 2–3(–4) pairs of main side-nerves, venation reticulate, upper surface with short patent

hairs on the nerves and with small prickles between the veins, lower surface with long patent hairs and with needle-shaped, 2.5 mm long prickles on nerves and veins below. *Petiole* 2.5–9 cm long. *Stipules* ovate, 9–15 by 6–12 mm, base cordate to rounded, margin finely fimbriate. *Flowers* soli-

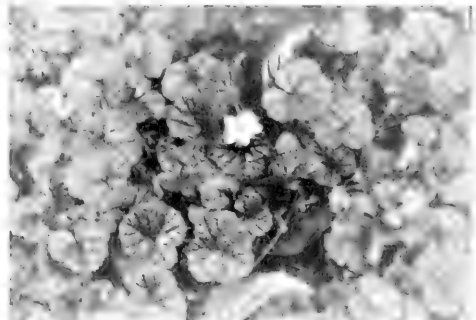


Fig. 7. *Rubus calycinus* D. Don. Mt Arjuno, Java. Photo C.G.G.J. van Steenis.

tary, terminal on the laterals, up to 2 cm long stalked, rarely also one flower in the uppermost (reduced) leaf. *Hypanthium* 3.5–5 mm across, patently hairy outside and with many needle-like, up to 2.5 mm long prickles. *Sepals* elliptic to ovate, sometimes cordate, 11–16 by 5–13 mm, in fruit growing to 20 by 15 mm, exposed margins pinnately lobed with up to 14 lobes, indumentum outside as hypanthium. *Petals* elliptic to ovate, 10–11 by 5–7 mm, white. *Stamens* 30–40, glabrous, filaments up to 6 mm, anthers 0.8–1 mm long. *Pistils* 30–50(–70), ovaries glabrous, on elevated, glabrous torus, styles up to 5 mm long. *Fruits* orange to red, mesocarp fleshy, only a thin layer when dry, stone 3–4 mm long, endocarp rugulose. – **Fig. 7.**

Distribution – Himalaya region from Nepal to Arunachal Pradesh, NE India, N Burma, S China; *Malesia*: only E Java.

Habitat – In continental Asia in forests, at 1200–2600 m altitude, in Java in different forest types, locally gregarious, at 1900–2800 m altitude.

Note – The differences between plants from the Continent and from Java are very slight, see Zandee & Kalkman, l.c. The description above is based on plants from Java.

46. *Rubus pectinellus* Maxim., Mém. Biol. Acad. St. Pétersb. 8 (1872) 374 (= Bull. Acad. St. Pétersb. 17); Elmer, Leaflet. Philipp. Bot. 2 (1908) 448; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 229. — Type: *Maximowicz s.n.*, Japan.

Main stems thin and wiry, creeping, up to 2 m long, rooting, with up to 20 cm long, erect, little

or not branched laterals, all stems patently soft-hairy, prickles rather few, up to 3 mm. *Leaves* reniform, 2–5.5 by 2–6 cm, shallowly 3(–5)-lobed, base deeply cordate, margin serrate, apex rounded, thinly herbaceous, nervation pedate with (1–)2 pairs of main side-nerves, venation widely reticulate, upper surface long-hairy between the veins, lower surface long-hairy and with needle-like prickles on nerves and veins. *Petiole* (1–)2–6 (–8) cm long. *Stipules* up to 8 by 10 mm, deeply digitately divided into up to 8 lobes. *Flowers* solitary, terminal on the laterals, rarely also 1–2 flowers in the axils of the upper (reduced) leaves, up to 3 cm stalked above uppermost true leaf. *Hypanthium* 3–4(–6) mm across, with long, soft, patent hairs and many needle-like, up to 4 mm long prickles outside. *Sepals* elliptic, 8–10 by 3–10 mm, growing to 12 by 13 mm in fruit, exposed margins pinnately 5–10-lobed, indumentum outside as hypanthium. *Petals* elliptic, 10–13 by 6–9 mm, white. *Stamens* 16–30, glabrous, filaments up to 5 mm, anthers 1–1.2 mm long. *Pistils* 24–40, ovaries with few long hairs, on elevated, hairy torus, the styles 3–4 mm long. *Fruits* orange to red, mesocarp thin, juicy, stone 2.5–3 mm long, endocarp smooth at first, later rugulose.

Distribution – SE China, Taiwan, Japan; *Malesia*: Philippines (Luzon, Mindoro, Mindanao).

Habitat – In the Philippines in primary and secondary forest, also in mossy forest, altitude 750–2750 m. In China, Taiwan, and Japan in woods, at comparable altitude.

Note – The description is based on Philippine specimens only.

Subgenus *Rubus*

Subgenus *Eubatus* auct.

47. *Rubus plicatus* Weihe & Nees, Rubi Germ. (1822) 15, t. 1.

Small shrubs. *Stems* sparsely hairy, prickles few. *Leaves* pedately 5-foliolate or 3-foliolate, petiole 2–4.5 cm long. *Stipules* on the base of the petiole, linear, up to 12 by 1.5 mm, persistent. *Leaflets* ovate to elliptic, terminal ones largest, 3–5.5 by 2–4 cm, base rounded to slightly cordate, margin serrate, apex acute to acuminate, nervation pinnate with 8–10 pairs of nerves, upper surface sparsely hairy on and between the nerves, lower surface denser hairy all over. *Inflorescence* a terminal thyrse with up to 5 few-flowered mono-

chasia under the terminal flower, the lower laterals in leaf-axils. *Bracts* and bracteoles persistent. *Pediceles* and other axes hairy. *Flowers* bisexual. *Hypanthium* c. 4 mm across. *Sepals* equal, ovate-triangular, c. 5 mm long, acuminate, entire. *Petals* orbicular, c. 8 mm, pink. *Stamens* c. 100, glabrous. *Pistils* c. 40, glabrous. *Fruits* not seen.

Distribution – This is one of the ‘microspecies’ of the *Rubus fruticosus* complex. It was introduced (probably from the Netherlands) in the 19th century and planted near the top of Mt Pangerango in West Java. Specimens have been collected several times, possibly always from the same bush. It may still be alive, but the most recent collection seen was

made in 1931. Fruits were never collected and the plants may be sterile. The description was made from the Java plants only.

Note — Other microspecies may also have been introduced from Europe.

INCOMPLETELY KNOWN SPECIES

Three species of which material is not yet satisfactory, are mentioned by Kalkman, *Blumea* 29 (1984) 381–382. They belong to subgenus *Malachobatus*.

DUBIOUS NAMES

Rubus chartaceus Kuntze, *R. edanoi* Merr., *R. grewiaefolius* Koord. ex Focke, *R. guttans* Focke,

R. koordersii Focke, *R. peltinervius* Focke, *R. reinwardtii* Kuntze, and *R. zambalensis* Elmer are dubious names for species reported from Malesia. Types of these species were either not seen or are insufficient.

Rubus diclinis F. Muell. var. *papuanus* Focke.

Neotypification with *Brass* 30932 not accepted as in serious conflict with protologue. The specimen mentioned is *Rubus trigonus*.

Rubus mindanaensis Focke, Ann. Cons. Jard. Bot. Genève 20 (1917) 104.

Considered by Focke to be related to *R. niveus* which, according to the material seen, is in the Philippines restricted to Luzon. Type (*Warburg* 14483) not seen.

TRIBUS POTENTILLEAE

Herbs, rarely shrubs. Leaves pinnate, trifoliolate, or palmate. Stipules adnate to petiole. Epicalyx present. Pollen opercular. Few to many pistils on a mostly elevated torus, not entirely enclosed by hypanthium. Ovule 1, pendulous. Achenes. $x = 7$.

FRAGARIA

Fragaria L., Sp. Pl. (1753) 494; Kalkman, *Blumea* 16 (1968) 349. — Type species: *Fragaria vesca* L.

Herbs, mostly with stolons. Leaves trifoliolate. Inflorescences cymose, few-flowered. Flowers 5-merous. Petals white. Stamens many. Pistils many, style ventral. Fruits on enlarged, fleshy torus, forming a spurious fruit.

Distribution — About 8 species, in Northern temperate regions and in Central and South America. Not indigenous in Malesia.

KEY TO THE SPECIES

- 1a. Flowers small: hypanthium up to 3 mm diam., sepals 3–4 mm long, petals 4–6 mm long **2. F. vesca**
- b. Flowers larger: hypanthium 4–6 mm diam., sepals 7–12 mm long, petals 9–12 mm long **1. F. × ananassa**

1. *Fragaria vesca* L., Sp. Pl. (1753) 494; Backer & Bakh. f., Fl. Java 1 (1964) 517.

Leaflets 1.5–3 by 1–2.5 cm, terminal petiole 0–1(–2) mm. Hypanthium 2.5–3 mm diam. Epicalyx leaves and sepals 3–4 mm long. Petals 4–6 mm long. Stamens 20 or less. Spurious

fruits obovoid, up to c. 1.5 by 1 cm, achenes not sunken in fleshy torus.

Distribution — Temperate Eurasia; in Malesia introduced and cultivated (not commercially), in some places escaped and naturalized, seen from Sumatra, Malaya, Java, Philippines, and Papua New Guinea, but possibly also elsewhere.

2. *Fragaria* × *ananassa* (Duch.) Guédès, Taxon 33 (1984) 724, and see also the editorial note to this paper by D.H. Nicolson; Backer & Bakh. f., Fl. Java 1 (1964) 517. — *Fragaria chiloensis* (L.) P. Miller × *Fragaria virginiana* P. Miller.

Leaflets 2–7 by 1.5–6 cm, terminal petiole up to 9 mm. *Hypanthium* 4–6 mm diam. *Epicalyx leaves* 5–8 by 2.5–3.5 mm. *Sepals* about equal to epicalyx or longer, 7–12 by 3–4.5 mm. *Petals* 9–12 by 9–12 mm. *Stamens* 25–40. *Spurious*

fruits globose, ovoid, or obovoid, up to 2 by 1.5 cm, achenes sunken in fleshy torus.

Distribution — Cultigen, dispersed all over the world, also running wild. In *Malesia* a female form not or rarely setting fruit (see Kalkman, Blumea 16, 1968, 352) naturalized on Mt Pangerango, W Java, where it was introduced around 1840.

Uses — Commercially grown for its fruits, e.g. in Java (Dieng) and Sumatra (Berastagi); see Choo-pong Sukumalanandana & E.W.M. Verheij in E.W.M. Verheij & R.E. Coronel (eds.), Plant Res. SE Asia (PROSEA Handbook) 2 (1991) 171–175.

POTENTILLA

Potentilla L., Sp. Pl. (1753) 495; Kalkman, Blumea 16 (1968) 325–354; *ibid.* 34 (1989) 143–160. — Type species: *Potentilla reptans* L.

Duchesnea J.E. Sm., Trans. Linn. Soc. 10 (1811) 372. — Type species: *Duchesnea fragiformis* J.E. Sm., nom. illeg. = *Fragaria indica* Andrews = *Duchesnea indica* Focke in Engler & Prantl.

Herbs of different habit, rarely shrubs. *Leaves* compound (palmate, pinnate, trifoliolate, rarely unifoliolate). *Stipules* adnate to the petiole, herbaceous or membranous. *Flowers* solitary and axillary or opposite the leaves, or in cymose or thyrsoid inflorescences, 5- (4–6)-merous, bisexual. *Hypanthium* (shallowly) cup-shaped, lined inside by a sometimes hairy disc. *Epicalyx* leaves often incised. *Sepals* valvate, usually entire. *Petals* entire, yellow or white, rarely red or purple. *Stamens* many (up to c. 30) to few. *Pistils* many to few, on low to elevated torus; ovaries superior, 1-locular; style apical, ventral or basal, persistent or jointed and deciduous; ovule 1, pendulous or ascending, inserted near the place of style-insertion. *Fruits* free, dry achenes or mesocarp slightly fleshy, surrounded by persistent epicalyx and calyx, torus rarely enlarging and becoming spongy to fleshy. *Seed* with thin testa. — **Figs. 8, 9.**

Distribution — About 250–400 species, worldwide but mainly in the Northern hemisphere. In *Malesia* 18 species with a centre of diversity (14 species) in New Guinea.

Habitat — Plants from open and sunny, often wet places. In *Malesia* most species montane to subalpine or alpine, at altitudes between 2400 and 4600 m, two species (*P. indica* and *P. sundaica*) between 800 and 2400 m.

Ecology — The (sub)alpine species in New Guinea often growing in cushions.

Note — Sometimes parts of the genus as delimited here, are regarded as separate genera, e.g. *Argentina* (to which several Malesian species probably would have to be referred if the genus were accepted), *Comarum* (not in *Malesia*), and *Duchesnea*. The latter two differ from *Potentilla* in developing a swollen, spongy torus. It seems a certainty to me that this is a polyphyletically acquired character state. Separation and recognition of the two genera leads to a paraphyletic genus *Potentilla*. Also for *Fragaria*, and for the same reasons, the combination with *Potentilla* could be considered. This would, however, either necessitate hundreds of new combinations in *Fragaria*, or in the case of conservation, new and unfamiliar names for the strawberries. (See also Kalkman 1968).

1a. Leaves pinnate 2
b. Leaves ternate or palmate 17
2a. Flowering stems as long as or distinctly longer than the leaves. Stamens usually 10 or more (often 5 in *P. parvula*) 3
b. Flowering stems shorter than the leaves. Stamens usually in one whorl of 4 to 6 (10–15 in *P. gorokana*) 10
3a. Leaflets densely silky hairy below, leaf surface not visible between the hairs . . 4
b. Leaves glabrous to hairy, but not densely silky, leaf surface visible 7
4a. Stems, petioles, and rachis patently hairy. Flowering stems procumbent
7. *P. hooglandii*
b. Stems, petioles, and rachis appressed hairy 5
5a. Ovaries hairy 2. *P. borneensis*
b. Ovaries glabrous 6
6a. Epicalyx leaves entire or practically so. Leaflets crowded, stiff 1. *P. adinophylla*
b. Epicalyx leaves pinnatifid to pinnatisect. Leaflets distant, not stiff 13. *P. papuana*
7a. Lateral leaflets entire or some with one incision, apical leaflet bifid . 9. *P. indivisa*
b. Leaflets incised 8
8a. Leaflets pseudodigitate (pinnately incised but with a minimally short midrib
11. *P. linilaciniata*
b. Leaflets pinnatisect to pinnatipartite 9
9a. Upper leaflets normally shorter than 10 mm, leaf not more than 10 cm long. Stamens as many as petals or twice that number, rarely more (–20) 14. *P. parvula*
b. Upper leaflets 10–30 mm, leaf 9–35 cm long. Stamens 4 times the number of petals or more 15. *P. polyphylla*
10a. Leaflets digitate, incisions going to the very base 6. *P. habbemana*
b. Leaflets entire, bipartite, or pinnately incised 11
11a. Leaflets pinnatisect to pinnatipartite 12
b. Leaflets undivided or bipartite to the very base 16
12a. Epicalyx leaves entire or apically shallowly notched 13
b. At least part of the epicalyx leaves pinnatifid to pinnatipartite, or 3–4-partite . . 15
13a. Leaflets densely silky hairy below, leaf surface not visible between the hairs . . 14
b. Leaflets with long hairs below but not densely silky, leaf surface visible
4. *P. foersteriana*
14a. Leaflets 4–5 pairs 12. *P. manganii*
b. Leaflets 12–18 pairs 18. *P. wilhelminensis*
15a. Leaflets 3–6 pairs. Stamens same number as sepals 10. *P. irianensis*
b. Leaflets 14–18 pairs. Stamens 2 or 3 times the number of sepals 5. *P. gorokana*
16a. Leaflets 8–13 pairs 16. *P. simulans*
b. Leaflets 1–5(–8) pairs 3. *P. brassii*
17a. Leaves 5-foliolate. Flowers in dichasial, terminal inflorescences 17. *P. sundaica*
b. Leaves trifoliolate. Flowers solitary, opposite normal leaves on prostrate stems
8. *P. indica*

1. **Potentilla adinophylla** Merr. & Perry, J. Arnold Arbor. 21 (1940) 190; P. van Royen, Alpine Fl. New Guinea 4 (1983) 2447, f. 719. — Type: *Brass 1308*, Mt Albert Edward.

Rosette plants with stout taproot, leaves and inflorescences erect. *Leaves* pinnate, up to 7 cm long, petiole 0.5–1 cm. *Stipules* membranous. *Leaflets* 12–18 pairs, crowded and often folded along midrib, up to 8 by 6 mm, serrate to pinnatisect with 3–8 pairs of incisions, densely sericeous below, less densely above; no intermediary leaves. *Flowering stems* almost scapose, erect, with 1 or 2 flowers, 4–12 cm long, sericeous. *Hypanthium* 3.5–4.5 mm diam., densely sericeous outside. *Epicalyx* leaves elliptic to ovate, 2–3.5 by 1.2–2 mm, entire or apically notched, sometimes with shallow incisions, densely sericeous outside. *Sepals* triangular, 2.5–4 by 1.2–2 mm, indumentum as epicalyx. *Petals* not seen. *Stamens* 10–20, filaments up to c. 1.5 mm, anthers c. 0.5 mm long. *Torus* elevated, densely hairy. *Pistils* many, ovary glabrous on hairy stalk, style inserted in the middle. *Achenes* c. 1.2 by 0.8 mm, brown, smooth.

Distribution – New Guinea.

Habitat – In grassland, 3100–4100 m altitude.

Note – Some ten specimens known from mountains in Papua New Guinea (Central and Milne Bay Prov.) and two from Mt Ngga Simanggela (Doornan) in Irian Jaya, the latter with a less rigid habit.

2. **Potentilla borneensis** (Stapf) Kalkman, Blumea 16 (1968) 332. — *Potentilla leuconota* D. Don var. *borneensis* Stapf, Trans. Linn. Soc. II, 4 (1894) 146. — Type: *Haviland 1058*, Mt Kinabalu.

Potentilla leuconota auct. non D. Don: Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 242; Merr., Not. Nat. Acad. Nat. Sc. Philad. n. 47 (1940) 3.

Rosette plant, taproot firm. Stems, petioles, rachis, underside of leaflets, and pedicels densely sericeous. *Leaves* pinnate, 5–18(–32) cm long, petiole 1–4(–9) cm. *Stipules* membranous. *Leaflets* 7–16(–24) pairs, elliptic to oblong, gradually larger to the tip, up to 7–19(–21) by 4–9(–10) mm, pinnatifid to pinnatisect, rarely incised to near the midrib, with (4–)6–11 incisions on either side; intermediary leaflets present or not. *Flowering stems* 1 to several, erect or ascending, (3–)5–30(–40) cm, cauline leaves few or none. Thyrses with up to 13 flowers. *Hypanthium* 2.5–3.5 mm diam., densely sericeous outside as are epicalyx and sepals. *Epicalyx* leaves elliptic or ovate to oblong,

2.5–5 by (0.7–)1–1.7 mm, apically notched or entire, rarely deeper incised. *Sepals* triangular to triangular-ovate, 2.5–4.5 by 2–3.2 mm. *Petals* elliptic to suborbicular, 6–8.5 by 4–6.5 mm, yellow. *Stamens* 20, filaments up to 2 mm, anthers 0.5 to 0.7 mm. *Torus* low, hairy. *Pistils* few to many, ovary hairy on a hairy stalk, style lateral. *Achenes* up to c. 2 by 1.5 mm, brown, smooth with some veins.

Distribution – Sumatra (only seen from Aceh), Borneo (only seen from Mt Kinabalu).

Habitat – In stony places on and between rocks, sheltered or open, in heath-like vegetation or shrubland, sometimes in swampy places. In Aceh collected at 2500–3500 m altitude, on Mt Kinabalu at 3500–4000 m.

Notes – Closely related to *P. leuconota* from the Himalayas and Taiwan, and to *P. papuana* from Celebes and New Guinea. For the distinction as species, see Kalkman (1968).

Recently Soják (Preslia 64, 1992, 221) separated the Sumatran material as *P. sumatrana* Soják. Recognition on a varietal level would have been more acceptable, as the differences between the populations from Aceh and Mt Kinabalu are either overlapping or of minor importance.

Some Sumatran specimens have deeply incised leaflets and may represent a variety (see also note under *P. papuana*).

3. **Potentilla brassii** Merr. & Perry, J. Arnold Arbor. 21 (1940) 185. — *Potentilla foersteriana* Laut. var. *brassii* (Merr. & Perry) Kalkman, Blumea 16 (1968) 343; P. van Royen, Alpine Fl. New Guinea 4 (1983) 2435, pl. 173. — Types: *Brass & Meijer Drees 10156*, holo; *Brass 9427*, *Brass & Meijer Drees 10390*; all Mt Trikora (Wilhelmina).

Potentilla archboldiana Merr. & Perry, J. Arnold Arbor. 21 (1940) 185. — Types: *Brass & Meijer Drees 10133*, holo; 9839; both Mt Trikora.

Small and compact rosette-herbs, growing individually or in cushions up to 60 cm diam. *Leaves* pinnate, 1–1.5 cm long, petiole very short. *Stipules* membranous, hairy outside. *Leaflets* 1–5(–8) pairs, bipartite or entire, 2.5–5 by 0.5–2 mm, hard and stiff, glabrous to hairy. *Flowering stems* less than 1 cm, with 2 reduced leaves under the terminal flower. *Flowers* (3–)4–5-merous. *Hypanthium* 1.5–2 mm diam., growing after anthesis, glabrous to sparsely hairy outside. *Epicalyx* leaves elliptic, 1.2–1.5 by 0.5–1 mm, entire, sometimes partly or all bipartite, indumentum as hypanthium. *Sepals* triangular, about as long as

epicalyx, acute. *Petals* (ob)ovate, c. 2 by 1 mm, yellow. *Stamens* isomerous with sepals, filaments very short, anthers c. 0.5 mm. *Torus* low, hairy. *Pistils* 6–15, ovary glabrous on hairy stalk, style lateral. *Achenes* 1–1.2 mm long, red.

Distribution — New Guinea, several mountains in the main range.

Habitat — Only from altitudes above 3350 m.

KEY TO THE VARIETIES

1a. Leaves up to c. 1 cm long, leaflets 3–5 pairs, densely hairy below in the middle part

c. var. **strigosa**

b. Leaves glabrous below or at most with few hairs 2

2a. Leaflets 2–5(–8) pairs, most bipartite to the base, rarely partly undivided or with an additional smaller third lobe . . . a. var. **brassii**

b. Leaflets 1–2 pairs, undivided b. var. **simplex**

a. var. **brassii** — Kalkman, *Blumea* 34 (1989) 150, f. 2. — *Potentilla archboldiana* Merr. & Perry.

Often growing in cushions. *Leaflets* 2–5(–8) pairs under the apical one, bipartite, usually to the base, rarely less deeply divided or some of them undivided, rarely with a third lobe, lobes 2.5–3.5 by 0.5–0.7 mm, glabrous to sparsely hairy. *Hypanthium* c. 2 mm diam., glabrous or sparsely hairy outside. *Petals* obovate. *Pistils* 6–15.

Distribution — New Guinea.

Habitat — Usually in boggy places, altitude 3400–4250 m.

b. var. **simplex** Kalkman, *Blumea* 34 (1989) 151. — Type: *Hope ANU 10832*, Mt Jaya.

Cushions. *Leaflets* 1–2 pairs under the apical one, glabrous or few hairs on apex and margin, lateral leaflets undivided, 3–5 by 1–2 mm, apical leaflet bifid or trifid, up to 6 by 3 mm. *Hypanthium* c. 1.5 mm diam., glabrous outside. *Petals* ovate. *Pistils* 9–12.

Distribution — New Guinea: Irian Jaya.

Habitat — Vegetation on poor soils, 3350–c. 4000 m altitude.

c. var. **strigosa** Kalkman, *Blumea* 34 (1989) 151. — Type: *Mangen 2011*, Valentijn Mts.

Cushions. *Leaflets* 3–5 pairs under the apical one, unequally bipartite to the base, the largest lobe up to c. 3 by less than 1 mm, glabrous above, den-

sely long appressed hairy below except near margins, petiole and rachis densely long-hairy. *Hypanthium* c. 2 mm diam., glabrous outside except near the rim. *Petals* elliptic-ovate. *Pistils* 8–10.

Distribution — New Guinea, only seen from Valentijn Mts, Irian Jaya.

Habitat — Boggy open places, 3340–3500 m.

4. ***Potentilla foersteriana*** Laut., Fedde Rep. 13 (1914) 240; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 242; Kalkman, *Blumea* 16 (1968) 341, excl. var. *brassii*; P. van Royen, Alpine Fl. New Guinea 4 (1983) 2434, pl. 172, f. 717, excl. var. *brassii*. — Type: *Keysser 309*, Finisterre Mts.

Rosette plants with firm taproot, solitary or in cushions. *Leaves* pinnate, 2–13 cm long, petiole up to 1.5 cm. *Stipules* membranous, long-hairy below, at least in the central part. *Leaflets* (5–)8–16 pairs, elliptic to ovate, base rounded to cordate, often unequal, pinnatisect to pinnatipartite, rarely with small intermediary leaflets. *Flowering stems* short, 1- to 3-flowered. *Flowers* (4–)5(–6)-merous. *Hypanthium* densely long-hairy outside. *Epicalyx* leaves elliptic to ovate, 2–4.5 by 1–2.5 mm, normally undivided, rarely notched apically, usually with long hairs outside. *Sepals* triangular, 2–4.5 by 1–3 mm, acute, indumentum as epicalyx. *Petals* elliptic to obovate, 3–7 by 1.5–3.5 mm, yellow. *Stamens* 5–10, filaments up to 1.5 mm, anthers c. 0.8 mm. *Torus* low, hairy. *Pistils* 12–50 or more, ovary glabrous on short hairy stalk, style lateral. *Achenes* up to 1.5 mm long, brown (to black). — **Fig. 8.**

Distribution — New Guinea.

Habitat — Open vegetation, (2300–)2700–4150 m altitude.

Note — *Potentilla brassii* was reduced to a variety of the present species in Kalkman (1968), but reinstated as a species in 1989.

KEY TO THE VARIETIES

1a. Leaflets (5–)8–12 pairs

a. var. **foersteriana**

b. Leaflets 12–16(–22) pairs . . . b. var. **ima**

a. var. **foersteriana** — Kalkman, *Blumea* 34 (1989) 152, f. 3.

Rosettes loose to compact, single or in cushions. *Leaves* 2–5 cm, with short petiole. *Petiole* and *rachis* almost glabrous to densely hairy. *Leaflets* (5–)8–12 pairs, 3.5–7 by 3–6 mm, pinnatisect



Fig. 8. *Potentilla foersteriana* Laut. var. *ima* Kalkman. Flowering rosette (Kalkman 4642). Photo C. Kalkman.

to pinnatipartite with (1-)2-7 incisions on either side, usually with long hairs at least on margin and apex, rarely almost glabrous. *Flowering stems* very short, at most 3 cm, with only 1 flower, rarely up to 3, peduncle with 1-2 small leaves or stipular bracts. *Hypanthium* 3-4 mm diam. *Epicalyx* leaves 2-4.5 by 1-3 mm. *Sepals* 2-4.5 by 1-3 mm. *Petals* (3-)4-6 by 1.5-3.5 mm. *Stamens* 5. *Pistils* 12-32.

Distribution - New Guinea, all over the island.

Habitat - Grasslands and other open vegetation, altitude 3225-4150 m.

b. var. *ima* Kalkman, Blumea 16 (1968) 342, pro max. parte; P. van Royen, Alpine Fl. New Guinea 4 (1983) 2436, pro max. parte; Kalkman, Blumea 34 (1989) 152, f. 4. — Type: Kalkman 4642, Mt Kerewa.

Solitary growing rosettes. *Leaves* 3-13 cm, petiole up to 1.5 cm. *Petiole and rachis* densely long-hairy. *Leaflets* 12-16 pairs, 6-11 by 3.5-8 mm, pinnatipartite with 1-4 incisions on either side, with long hairs below. *Flowering stems* short, up to 5(-7) cm, usually with 2 flowers, peduncle with 1-2 small leaves. *Hypanthium* 3-5 mm diam. *Epicalyx* leaves 2.5-4 by 1-2.5 mm. *Sepals* 2-3 by 1-3 mm. *Petals* 3-7 by 2-3.5 mm. *Stamens* 5-10. *Pistils* many, up to 50 or more. — **Fig. 8.**

Distribution - New Guinea, only seen from several mountains in Papua New Guinea.

Habitat - Often in grassland, altitude (2300-) 2700-3350(-4100) m.

Note - In its original circumscription this variety also included *P. gorokana*, now recognized as a separate species.

5. *Potentilla gorokana* Kalkman, *Blumea* 34 (1989) 155. — Type: *Hoogland & Pullen 5513*, Mt Kerigomna.

Solitary growing rosettes with stout, woody taproot, densely silky on petiole, rachis, underside of stipules, underside of leaves. *Leaves* pinnate, 5–11 cm long, petiole up to 0.5 cm. *Stipules* membranous. *Leaflets* 14–18 pairs, elliptic, 7–9 by 4–6 mm, pinnatisect with 2–5 incisions on each side, rarely with small intermediary leaflets. *Flowering stems* up to 3 cm, with 1–4 flowers, peduncle with few small leaves or stipular bracts. *Flowers* 5- or 6-merous. *Hypanthium* 3–5 mm diam., densely long-hairy outside. *Epicalyx* leaves elliptic, 3.5–4.5 by 1.5–3 mm, mostly pinnatifid to pinnatisect with 1–3 incisions on each side, long-hairy outside. *Sepals* triangular, 3–4 by 1.5–3 mm, indumentum as epicalyx. *Petals* 5–7 by 3–4 mm, yellow. *Stamens* 10–15, filaments c. 1 mm, anthers 0.5 mm. *Torus* low, hairy. *Pistils* many, c. 100, ovary glabrous, stalked, style lateral. *Achenes* c. 1 mm long, brown.

Distribution — New Guinea, the three specimens seen all from Goroka Subprov., Papua New Guinea.

Habitat — Open places, altitude 2650–3200 m.

6. *Potentilla habbemana* Merr. & Perry, *J. Arnold Arbor.* 21 (1940) 186; P. van Royen, *Alpine Fl. New Guinea* 4 (1983) 2452, f. 720. — Types: *Brass 9594*, holo; *9553, 9590*; all Mt Trikora (Wilhelmina).

Loose rosettes. *Leaves* pinnate, (2–)5–8 cm long, petiole up to 2.5 cm. *Stipules* membranous, underside silky in the middle. *Petiole and rachis* long silky hairy to glabrous. *Leaflets* 6–12 pairs, digitately divided to the base, lobes 3–6, up to 4 by 1 mm, acute to obtuse, entire, lower side silky in the middle. *Flowering stems* 1.5–4.5 cm, 1-flowered, peduncle with 1–2 leaves, silky. *Hypanthium* up to 4 mm diam., outside long-hairy or only hairs on rim. *Epicalyx* leaves elliptic to ligulate, 2–2.5 by 0.5–1 mm, entire or one apically notched, glabrous to sparsely hairy. *Sepals* triangular, 1.5–3 by 1.2–2 mm, indumentum as epicalyx. *Petals* obovate, 3–3.5 by 1.5–2 mm, yellow. *Stamens* 5, filaments 1 mm, anthers 0.5 mm. *Torus* low, hairy. *Pistils* 7–20, ovary glabrous on hairy stalk, style lateral. *Achenes* 1.2 mm long, greyish brown.

Distribution — New Guinea, only seen from Mt Trikora, Irian Jaya.

Habitat — Boggy places, heath-like vegetation, 3225–4000 m altitude.

7. *Potentilla hooglandii* Kalkman, *Blumea* 13 (1968) 339; P. van Royen, *Alpine Fl. New Guinea* 4 (1983) 2444, pl. 174. — Type: *Hoogland & Schodde 7245*, Lagaip Valley.

Rosette plants, forming prostrate, not-rooting, often long and branched runners bearing leaves and flowering laterals, taproot stout, all stems up to the pedicels patently long-hairy. *Leaves* pinnate, those of the rosette 5.5–21 cm long, petiole up to 4 cm. *Stipules* membranous, up to 2 cm long, sericeous outside. *Petiole and rachis* densely covered with long, soft, patent hairs. *Leaflets* 11–16 pairs, ± elliptic, basal ones 3–6 mm long, larger to the apex, up to (8–)10–24 by (4–)6–11 mm, pinnatifid to pinnatisect with 6–12 incisions on each side, densely sericeous below, intermediary leaflets usually present. *Flowering stems* procumbent, in axils of rosette and runner leaves, 4–27 cm long, with a terminal flower and one or few below it, peduncle with some (reduced) leaves. *Flowers* 5- or 6-merous. *Hypanthium* 3–4 mm diam., densely sericeous outside. *Epicalyx* leaves elliptic to ovate, 3–6.5 by 1.5–3.5 mm, serrate in upper part, indumentum outside as on hypanthium. *Sepals* (broadly) triangular to ovate, 3–4.5 by 2–3 mm, usually entire, indumentum as on hypanthium. *Petals* (sub)orbicular to obovate, 5–6 by 4–5 mm, yellow. *Stamens* 10–12 (–c. 20), filaments 1–1.2 mm long, anthers c. 0.5 mm. *Torus* thin to thick, hairy. *Pistils* very many, ovary glabrous, on short stalk with some hairs, style lateral below the middle. *Achenes* 1 by 0.8 mm, brown to dark purplish with lighter dorsal line, smooth. — **Fig. 9.**

Distribution — New Guinea, on several mountains.

Habitat — Open grasslands, altitudes 2440 to 3560 m.

8. *Potentilla indica* (Andr.) Wolf in Asch. & Graebn., *Syn. Mitt.-Eur. Fl.* 6, 1 (1904) 661; Wolf, *Bibl. Bot.* 71 (1908) 664; Kalkman, *Blumea* 16 (1968) 344. — *Fragaria indica* Andr., *Bot. Repos.* 7 (1807) t. 479; Steenis, *Bull. Jard. Bot. Buitenzorg III*, 13 (1934) 241; Backer & Bakh. f., *Fl. Java* 1 (1964) 517. — *Duchesnea indica* Focke in Engler & Prantl, *Nat. Pflanzenfam.* 3, 3 (1888) 33. — Type: Andrews, l.c., t. 479, picturing a plant from a garden in England, originating from NE Bengal, India.

Fragaria chrysantha Zoll. & Moritz, *Syst. Verz.* (1846) 7. — *Duchesnea chrysantha* Miq., *Fl. Ind. Bat. I*, 1 (1855) 372. — Type: *Zollinger 1987*, Mt Tangkubanperahu.

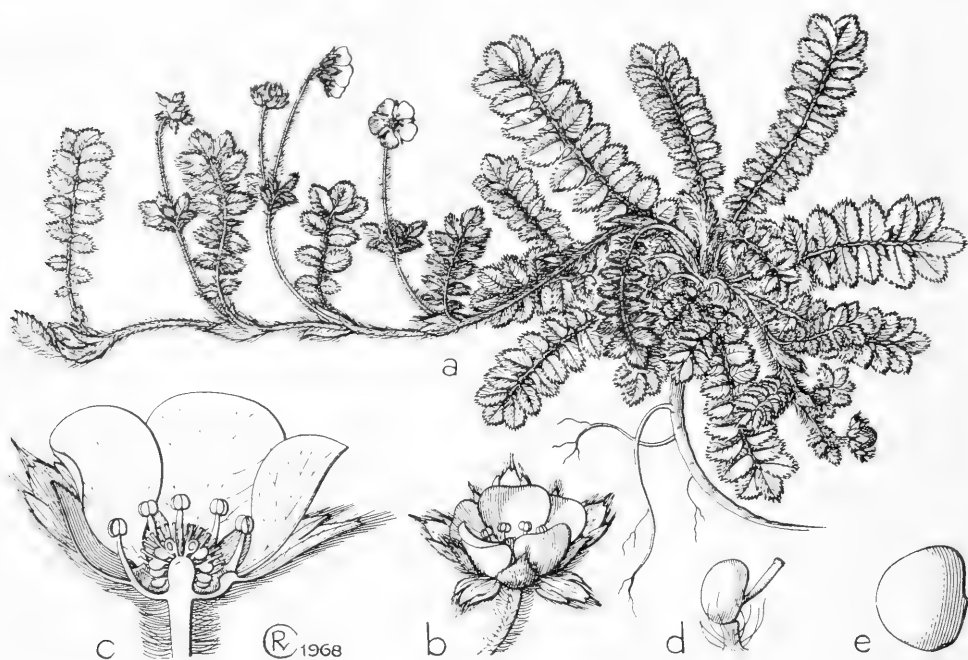


Fig. 9. *Potentilla hooglandii* Kalkman. a. Flowering plant, $\times 0.7$; b. flower, $\times 2$; c. flower, halved lengthwise, $\times 4$; d. ovary, $\times 12$; e. fruit, $\times 12$ (a: Hoogland 9693; b–d: Kalkman 4874, e: Kalkman 4745).

Rosette herbs with long, prostrate, partly sympodial stems (stolons) bearing leaves and flowers and also reduced leaves, daughter plants produced on the nodes bearing reduced leaves. Stems, pedicels and petioles with long, \pm patent hairs and usually many multicellular glandular hairs. *Leaves* trifoliate, petiole up to 12(–16) cm. *Stipules* membranous, c. 1 cm long, long-hairy outside. *Leaflets* sessile or shortly petioluled, apical leaflets rhomboid to obovate, 1.5–3.5 by 1–2.5 cm, base cuneate, apex rounded, serrate in upper part, lateral leaflets elliptic to ovate, slightly smaller and usually with unequal base, all leaflets long hairy below and on the nerves also with glandular hairs. *Flowers* solitary, seemingly placed opposite the runner-leaves, rarely 6-merous, pedicels 2–8 cm long. *Hypanthium* 2–3.5 mm diam., sparsely hairy outside. *Epicalyx* leaves \pm obovate, 3–5 by 2–3 mm during anthesis, distinctly growing afterwards, with 2–6 incisions in the apical part, sparsely hairy outside. *Sepals* narrowly triangular, 4–6 by 2–3 mm during anthesis, indumentum outside as epicalyx. *Petals* obovate, 3.5–4.5 by 2–3.5 mm, yellow. *Stamens* 15–20, filaments

up to 2.5 mm, anthers c. 0.5 mm. *Torus* elevated, hairy or glabrous, distinctly enlarging after anthesis. *Pistils* many, sessile, ovary glabrous, style inserted laterally above the middle and in anthesis much longer than the ovary. *Collective fruit* 5–11 mm diam, soft and fleshy, red. *Achenes* 0.9–1.3 by 0.7–1 mm, red to brownish, smooth or distinctly rugose to tuberculate.

Distribution – South, Southeast, and East Asia. In *Malesia* probably indigenous in Java, Lesser Sunda Islands and Philippines, cultivated as an ornamental, escaped from cultivation or at least doubtfully indigenous in Sumatra, Malaya, and Singapore. Also introduced and established in many places in Europe, America, and Africa.

Habitat – Mostly in disturbed habitats: roadsides, plantations, rarely in forest, rather often in damp or wet places; altitude 700–2300 m.

Uses – Perry & Metzger (Medicinal plants of E and SE Asia, 1980, 342) report many medicinal uses from China, especially for burns, bites, boils, etc. The fruits are almost tasteless but edible; they are, however, reported to be poisonous when too many are eaten.

Vernacular name — As a garden plant often called the Indian strawberry.

Notes — An extensive overview of the variation was given earlier (Kalkman 1968). Two groups can be distinguished, one with tuberculate achenes on a hairy torus, another with smooth achenes on a glabrous torus, the correlation of achene and torus characters not being absolute. Plants of the first-mentioned group have proven to be diploid $2n = 14$, plants of the second group were observed to be dodecaploid $2n = 84$. Japanese authors call them, respectively, *Duchesnea chrysantha* and *D. indica*. Published chromosome counts were almost exclusively made from Japanese or cultivated plants and none from Malesia. Sterile hybrids obviously occur in the wild in Japan and can also be artificially made; they are $7x$ or $8x$ and have been named *Duchesnea* \times *hara-kurosawae* Naruhashi & Sugimoto (J. Phytogeogr. & Taxon. 34, 1986, 11–14; see also Naruhashi et al. in La Kromosomo II-42, 1986, 1330–1335).

Because of the lack of any karyological evidence it is not warranted to extrapolate these findings to areas outside Japan, but chromosome counts of vouchered, wild growing specimens of both groups may establish the occurrence of two (sub)species in Malesia. Plants with tubercled achenes are in Malesia known from Luzon, Java, Bali, and Timor, plants with smooth achenes were seen from Luzon and other islands and seem to be always introduced or escaped.

For the distinction of *Duchesnea* as a genus, see the note on p. 286 under the genus description. When brought under *Potentilla* the group with the tubercled achenes cannot be called *P. chrysantha*, that combination being already occupied.

9. *Potentilla indivisa* Kalkman, Blumea 34 (1989) 155, f. 5. — Type: *Mangen 1163*, Mt Trikora (Wilhelmina).

Rosette herbs with stout taproot. *Leaves* pinnate, 9–10 cm long, petiole up to 2.5 cm. *Stipules* membranous, densely long-hairy outside. *Petiole and rachis* with few long, soft hairs, sticky when living (?). *Leaflets* 10–12 pairs, elliptic-ovate, oblique, 6–8 by 3–4 mm, lateral ones undivided and entire, rarely bifid with one smaller lobe, apical ones bifid, all leaflets leathery and glabrous except few short hairs at apex. *Flowering stems* up to 16 cm, branched, with c. 4 reduced leaves and a number of bracts, with up to 7 flowers, peduncle and pedicels sparsely hairy. *Hypanthium* c. 4 mm diam., hairy outside. *Epicalyx* leaves elliptic to triangular-elliptic, 2–2.5 by 1–1.5 mm in anthesis,

afterwards distinctly enlarging up to 5 mm, obtuse, entire, hard, with few hairs outside. *Sepals* triangular, 4 by 2.5 mm in anthesis, afterwards up to 6 mm long, indumentum as epicalyx. *Petals* obovate, 10 by 7 mm, yellow. *Stamens* 20, filaments c. 1 mm, anthers c. 0.8 mm. *Torus* hairy. *Pistils* 20–25, ovary glabrous on hairy stalk, style lateral. *Achenes* c. 1.5 mm long, brown.

Distribution — New Guinea, only one collection seen from Irian Jaya, N of Mt Trikora.

Habitat — In tussock grassland, 3100 m altitude.

Note — Related to *P. parvula*, but with entire lateral leaflets.

10. *Potentilla irianensis* Kalkman, Blumea 34 (1989) 156. — Type: *Hope ANU 16027*, Mt Jaya (Carstensen).

Rosettes growing in cushions of up to 40 cm diam. and 30 cm high. *Leaves* pinnate, very small, 0.5–1.5 cm long, petiole up to 2 mm, perpendicular to the stipule. *Stipules* membranous, sparsely to densely hairy outside. *Petiole and rachis* practically glabrous to long-hairy. *Leaflets* 3–6 pairs, elliptic, up to 2–3 by 1–2.5 mm, base rounded, tripartite to pinnatisect or pinnatipartite with 1–3 incisions on each side, with few hairs, intermediary leaflets sometimes present. *Flowering stems* at most (in fruiting stage) 1.5 cm long, with 1 or 2 flowers and few reduced leaves on the peduncle. *Hypanthium* up to 2.5 mm diam., almost glabrous outside. *Epicalyx* leaves ovate to obovate, tri- or quadripartite with incisions from the top, 1.2–1.5 by 0.7–1 mm, with few hairs. *Sepals* triangular-ovate, 1–1.5 by 0.7 mm, with some hairs or glabrous. *Petals* elliptic, c. 2 by 1 mm, yellow. *Stamens* 5(–7), very small. *Pistils* 8–12, on the hairy bottom of the hypanthium, ovary glabrous on hairy stalk, style lateral. *Achenes* c. 1.2 mm long, brown, on thick stalks.

Distribution — New Guinea, 6 collections seen, all from Mt Jaya in Irian Jaya.

Habitat — Alpine grassland and stony places, 3850–4600 m altitude.

11. *Potentilla linilaciniata* P. van Royen, Alpine Fl. New Guinea 4 (1983) 2455, f. 721. — Type: *Van Royen 30113*.

Solitary rosette herbs with stout, woody taproot. *Leaves* pinnate, 3–15(–30) cm long, petiole up to 3(–6) cm. *Stipules* membranous, silky outside. *Petiole and rachis* long appressed-hairy when young, glabrescent. *Leaflets* 12–18(–22) pairs, pseudo-digitately divided with incisions going to

the very short midrib, the 4–9 lobes 3–7 by 0.5–1 mm, acute, long-appressed-hairy to almost glabrous below. *Flowering stems* 4–20(–35) cm long, with (1–)2–5(–12) flowers. *Flowers* (4–)5-merous. *Hypanthium* 2–4.5 mm diam., long-hairy outside. *Epicalyx* leaves elliptic, 2–4(–5) by 0.5–2 mm, entire or apically notched, rarely deeper incised, hairy to almost glabrous. *Sepals* triangular, 2.5–4(–5.5) by 1–2.5 mm, indumentum as epicalyx. *Petals* obovate, 5–8.5 by 3.5–5 mm, yellow. *Stamens* 15–20, filaments up to 1.5 mm long, anthers c. 1 mm. *Torus* low to elevated, hairy. *Pistils* 15–35, ovary glabrous on hairy stalk, style lateral. *Achenes* c. 1.2 mm long, lightbrown, smooth.

Distribution – New Guinea, seen from several mountains in Papua New Guinea.

Habitat – Grasslands, usually swampy or boggy, 2700–3800 m altitude.

Note – The leaflets are not truly digitate but have a recognizable, although very short midrib. The large variation in length of leaf and inflorescence may hide two varieties (see discussion in Kalkman, *Blumea* 34, 1989, 157).

12. *Potentilla manganii* Kalkman, *Blumea* 34 (1989) 158. — Type: *Mangen 495bis*, Mt Trikora (Wilhelmina).

Cushion-forming rosettes. *Leaves* pinnate, up to 1.5–2.5 cm long, petiole less than 0.5 cm. *Stipules* membranous, silky hairy outside. *Petiole and rachis* long and densely silky hairy. *Leaflets* 4–5 pairs, elliptic, up to 5–7 by 3–3.5 mm, pinnatisect with 1–3(–5) incisions each side, densely silky hairy below. *Flowering stems* up to 1 cm, 1-flowered, with 2 reduced leaves on the densely hairy peduncle. *Hypanthium* 3.5 mm diam., long-hairy outside. *Epicalyx* leaves elliptic, 2–2.5 by c. 1 mm, entire or rarely notched at apex, long-hairy outside. *Sepals* narrowly triangular, 2–2.5 by 1.2 mm, indumentum as on epicalyx. *Petals* elliptic, 3.5 by 1.5 mm, yellow. *Stamens* 5, filaments 1 mm, anthers 0.2 mm. *Pistils* c. 25, on the hairy bottom of the hypanthium, ovary glabrous, stalked, style lateral. *Achenes* 1.2 mm long, shining dark purple.

Distribution – New Guinea, only two specimens seen, both from Mt Trikora, Irian Jaya.

Habitat – Dry, low vegetation, c. 4100 m altitude.

13. *Potentilla papuana* Focke, *Abh. Naturw. Ver. Bremen* 13 (1895) 162; Steenis, *Bull. Jard. Bot. Buitenzorg* III, 13 (1934) 243; Merr. &

Perry, *J. Arnold Arbor.* 21 (1940) 189; P. van Royen, *Alpine Fl. New Guinea* 4 (1983) 2449, pl. 175. — *Potentilla leuconota* D. Don var. *papuana* F. Muell., nomen. — Type: *MacGregor s.n.*, Owen Stanley Range.

Potentilla leuconota auct. non D. Don: F. Muell., *Trans. Roy. Soc. Vict.* 1, 2 (1889) 5; Steenis, *Bull. Jard. Bot. Buitenzorg* III, 13 (1934) 242.

Rosette herbs, occasionally forming long, prostrate stems, taproot stout. *Leaves* pinnate, (4.5–) 6–15(–20) cm long, petiole up to 5.5(–7) cm. *Stipules* of the rosette leaves membranous, light brown, outside hairy at least in the centre. *Petiole and rachis* densely hairy. *Leaflets* 7–11 pairs, elliptic to oblong or ovate, the upper ones (7–)11–22 by (4–)6–13 mm, pinnatifid to pinnatisect with 4–14 incisions on either side, densely silvery sericeous below and less densely above, intermediary leaves usually present. *Flowering stems* several per rosette, prostrate or ascending, (5–)10–30 (–45) cm, with some (reduced) leaves with herbaceous, green stipules, usually branched with under the terminal flower 1–6 laterals with 1–3 flowers each. *Bracts* leaf-like but small. *Flowers* 5(–7)-merous. *Hypanthium* 4–5 mm diam., densely sericeous outside. *Epicalyx* leaves ovate to obovate, 3–6 by 2–4 mm, growing after anthesis, pinnatifid to pinnatisect with (1–)3–6 incisions on either side, densely sericeous outside. *Sepals* triangular to ovate, 3–6 by 2–3 mm, indumentum as epicalyx. *Petals* elliptic to obovate, 5–8 by 3.5–6 mm, yellow. *Stamens* 10–30, filaments 1–2 mm, anthers 0.5–0.8 mm long. *Torus* low to high, hairy. *Pistils* very many, ovary glabrous on a hairy stalk, style lateral at about the middle. *Achenes* 1.2–1.5 mm long, brown to dark purplish brown, smooth.

Distribution – Philippines (only one collection seen, Mt Tabayoc, Luzon), Celebes, New Guinea.

Habitat – Alpine and subalpine grasslands, wet or dry, more rarely in shrubland, at (2100–)2600–3900 m altitude.

Notes – Some New Guinean specimens have deeply incised leaflets, as also occur in Sumatran specimens of *P. borneensis* (see note under that species).

One chromosome count has been made by Borgmann (*Zs. f. Bot.* 52, 1964, 143), $2n = 42$. See under *P. parvula*.

14. *Potentilla parvula* Hook. f. ex Stapf in Hook., *Ic. Plant.* IV, 3 (Jan. 1894) pl. 2294; Stapf, *Trans. Linn. Soc. Lond.* II, 4 (Dec. 1894) 147; Steenis, *Bull. Jard. Bot. Buitenzorg* III, 13

(1934) 243; P. van Royen, *Alpine Fl. New Guinea* 4 (1983) 2441. — Type: *Haviland 1057K*, Mt Kinabalu.

Potentilla philippinensis Merr., Philipp. J. Sc. 29 (1926) 480; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 243. — Type: *Clemens 5006*, Mt Pulog.

Potentilla novoguineensis Merr. & Perry, J. Arnold Arbor. 21 (1940) 187. — Types: *Brass 10727*, Lake Habbema, holo; 4229, Mt Albert Edward; 4636, Wharton Range; *Brass & Meijer Drees 9863*, Mt Trikora.

Lax to compact rosette herbs, rarely with prostrate runner-like branches, taproot stout to slender. Indumentum of vegetative parts variable but usually sparsely long-hairy. *Leaves* pinnate, 2–10 cm long, in shaded places up to 25 cm, petiole 0.3–2.5 cm long. *Stipules* of rosette leaves membranous, about halfway adnate. *Leaflets* 6–21 pairs, suborbicular to elliptic, ovate, or obovate, up to 3–9(–13) by 2–6(–9) mm, pinnatisect to pinnatifid with 1–5(–8) incisions on either side, intermediary leaflets mostly present in the larger plants. *Flowering stems* several per rosette, 2.5–20 cm long, in deep shade up to 38 cm, with some cauline leaves with herbaceous stipules, bearing up to 4(–6) flowers, usually sparsely long-hairy. *Flowers* (4–)5(–6)-merous. *Hypanthium* 2–4 mm diam., hairy outside. *Epicalyx* leaves suborbicular to elliptic or obovate, 1.5–3.5 by (0.5–)1–3.5 mm, growing after anthesis, entire or notched at apex, subglabrous to sparsely hairy outside. *Sepals* triangular, 1.8–4 by 1–2.5 mm, indumentum as on epicalyx. *Petals* elliptic to obovate, up to 8 by 4 mm but usually smaller, yellow. *Stamens* 5–10 (–20), filaments 1–2 mm, anthers 0.5–0.8 mm long. *Torus* cone-shaped, hairy. *Pistils* many, rarely few, ovary glabrous, on short, ± hairy stalk, style lateral at about the middle. *Achenes* up to 1.3 mm long, brown to purplish or blackish, smooth.

Distribution — Borneo (only seen from Mt Kinabalu), Philippines (seen from some mountains in Luzon), Celebes (only seen from Mt Rante Mario), New Guinea.

Habitat — Mostly in alpine or subalpine grasslands, wet or dry, more rarely in shaded places like open forest, forest edges, and shrubland, at (2065–) 2600–3800(–4100) m altitude.

Notes — The habit seems to be related to the light conditions in the growing place. Solitary growing plants in open conditions may form compact rosettes while in shaded places the rosette is lax and open, with longer and more slender leaves and inflorescences. See Kalkman, *Blumea* 16 (1968) 337.

One chromosome count has been made by Borgmann (Zs. f. Bot. 52, 1964, 144, sub *P. novoguineensis*), $2n = 42$. The voucher, *Borgmann 24*, is not quite homogeneous. See also under *P. papuana*.

15. *Potentilla polyphylla* Wall. [Cat. (1829) nr. 1026, nomen] ex Lehm., Nov. et Min. Cogn. Stirp. Pug. 3 (1831) 13. — Type: *Wallich 1026*, Gossain Than.

Potentilla mooniana Wight, Ic. 1 (1840) t. 233, text p. xlv; Steenis, Trop. Natuur 21 (1932) 101, f. 3, 4; Bull. Jard. Bot. Buitenzorg III, 13 (1934) 243; Backer & Bakh. f., Fl. Java 1 (1964) 518. — Type: *Wight*, Nuwara Eliya, Sri Lanka.

Rosette herbs with leafy flowering stems. *Leaves* pinnate, 9–35 cm long, petiole 1.5–10 cm. *Stipules* of rosette leaves membranous, hairy outside. *Petiole and rachis* hairy. *Leaflets* 10–20 pairs, elliptic, up to 10–30 by 5–12 mm, pinnatisect to serrate with (5–)7–12 incisions on either side, sparsely long-hairy, intermediary leaflets present. *Flowering stems* several per rosette, ascending to prostrate, 14–45 cm long, with some cauline leaves with herbaceous stipules, hairy. *Inflorescence* a thyrse with a terminal flower and some lateral monochasia, 4–10 flowers per inflorescence. *Flowers* 5(–6)-merous. *Hypanthium* 3.5–5 mm diam., sparsely long-hairy outside. *Epicalyx* leaves ± elliptic, 3–4(–5) by 2–4(–5) mm, growing after anthesis, usually with 1–4 incisions going halfway or deeper, sparsely long-hairy outside. *Sepals* triangular, 3–4.5(–5) by 2–4 mm, indumentum as on epicalyx. *Petals* obovate to suborbicular, 5.5–6 by 5–6 mm, yellow. *Stamens* 19–24, filaments up to 2 mm, anthers 0.5–0.8 mm long. *Torus* cone-shaped, hairy. *Pistils* many, ovary glabrous on hairy stalk, style lateral in the middle. *Achenes* c. 1.5 mm long, brown, smooth.

KEY TO THE VARIETIES

- 1a. Leaflets serrate, the incisions always less than halfway. Stems, and especially leaf-rachis and pedicels soft-hairy, the hairs usually distinctly spreading. Intermediary leaflets often large, not rarely 2 or 3 between two primary leaflets. **b. var. *polyphylla***
- b. Leaflets pinnatisect, incised about halfway. Leaf-rachis and pedicels appressed soft-hairy, sometimes rather sparsely so. Intermediary leaflets present, small, never more than one between two primary leaflets.

a. var. *kinabaluensis*

a. var. kinabaluensis (Stapf) Kalkman, Blumea 16 (1968) 339. — *Potentilla mooniana* Wight var. *kinabaluensis* Stapf, Trans. Linn. Soc. Lond. II, 4 (1894) 146; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 243. — Type: *Haviland 1056*, Mt Kinabalu.

Distribution — Borneo, only seen from Mt Kinabalu.

Habitat — Sheltered, damp to peaty places, altitude c. 3300–4000 m.

b. var. polyphylla

Distribution — India, Nepal, Sikkim, Pakistan, Sri Lanka; *Malesia*: Java (Mt Papandayan).

Habitat — In Java in herbaceous vegetation, under *Anaphalis javanica* and *Alchemilla villosa*, altitude c. 2400 m.

Note — This variety has never been re-collected in Java since 1940, nor has it been collected in Sumatra as could be expected. One wonders about the possibility of its having been intentionally planted, but Mt Papandayan is not known as a place where plants have been introduced, like Mt Gede.

16. *Potentilla simulans* Merr. & Perry, J. Arnold Arbor. 21 (1940) 187; Kalkman, Blumea 16 (1968) 341, in syn. sub *P. foersteriana*; *ibid.* 34 (1989) 159. — Type: *Brass 9594A*, Mt Trikora (Wilhelmina)

Loose rosettes. *Leaves* pinnate, up to 5 cm long, petiole up to 8 mm. *Stipules* membranous, hairy outside. *Petiole* and *rachis* densely long-hairy. *Leaflets* 8–13 pairs, bipartite to the very base, lobes divergent, elliptic, unequal, the largest one up to 3.5 by 1.5 mm, with long appressed hairs underneath, especially in the middle. *Flowering stems* up to 1.5 cm long, 1-flowered and with some small leaves, densely hairy. *Hypanthium* c. 2 mm diam., long-hairy outside. *Epicalyx* leaves elliptic, entire or one shallowly notched, 1.5–2 by 1 mm, long-hairy outside. *Sepals* triangular, 1.5–2 by 1.5 mm, indumentum as epicalyx. *Petals* broadly obovate, 2–3 mm long, yellow. *Stamens* 5, filaments 0.5 mm, anthers 0.5 mm. *Pistils* 10–12, on the bottom of the hypanthium, ovary glabrous, on hairy stalk, style lateral. *Achenes* c. 1.2 mm long, shining dark purple.

Distribution — New Guinea, only seen from Irian Jaya.

Habitat — Grassland on peaty soil, altitude 3225–4350 m.

Note — Two of the three specimens seen were

taken from mixed collections so the epithet seems to be quite appropriate.

17. *Potentilla sundaica* (Blume) O. Kuntze, Rev. Gen. Pl. 1 (1891) 219; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 243; Backer & Bakh. f., Fl. Java 1 (1964) 518. — *Fragaria sundaica* Blume, Bijdr. (1826) 1106. — *Duchesnea sundaica* Miq., Fl. Ind. Bat. I, 1 (1855) 372, t. 6, incl. var. *hirsuta* Miq., l.c. 373. — Type: *Blume s.n.*, Mt Gede, L sheet nr 909.111-40. *Potentilla kleiniana* Wight & Arn. in Wight, Ill. Ind. Bot. 1 (1831) t. 85. — Type: *Wight 914*, India.

Loose rosettes with erect to prostrate, often rooting, flowering stems, stolons (prostrate stems without normal leaves) sometimes present. *Leaves* palmately (pedately) 5-foliolate, petiole 6–40 cm long. *Stipules* 1.5–4 cm long, membranous, little hairy outside. *Petiole* sparsely to densely soft-hairy. *Leaflets* obovate, terminal one shortly petioluled, 2–4.5 by 1–2.5 cm, lateral ones smaller, coarsely serrate, pinninerved, with few soft appressed hairs underneath. *Flowering stems* up to 45 (–60) cm, with the cauline leaves smaller than the rosette leaves and with herbaceous stipules, rarely 3-foliolate, stems and pedicels sparsely to densely soft-hairy. *Daughter plants* sometimes developing on the nodes of the stems. *Inflorescences* terminal and axillary, compound dichasia, whole inflorescence up to 5–10 cm long. *Bracts* and *bracteoles* leaf-like. *Hypanthium* 2–3 mm diam., sparsely hairy outside. *Epicalyx* leaves ± oblong, 2–3 mm long, entire or bifid, sparsely hairy outside. *Sepals* triangular, 2–3 by 1–2 mm, growing after anthesis, indumentum as epicalyx. *Petals* obovate, 3–3.5 by 2–3 mm, yellow, falling early. *Stamens* 20 or few missing, filaments c. 1 mm, anthers c. 0.5 mm long. *Torus* high and thin in anthesis, thicker under the fruit, with few hairs. *Pistils* many, ovary glabrous on hairy or glabrous stalk, style terminal to subapical. *Achenes* 0.7–1 mm long, reddish-brown to brown, rugose.

Distribution — India, Sri Lanka, S China, N Vietnam, Laos, Korea, Japan; *Malesia*: only in N Sumatra and W and C Java.

Habitat — Damp or marshy places like banks of brooks and lakes, also on roadsides and in villages, in Sumatra and Java at altitudes of 1200–2300 m.

18. *Potentilla wilhelminensis* P. van Royen, Alpine Fl. New Guinea 4 (1983) 2440, f. 718. — Type: *Versteeg 2534*, Mt Trikora (Wilhelmina).

Potentilla *prob. nov. spec.* Kalkman, *Blumea* 16 (1968) 348.

Rosette herbs, taproot stout. *Leaves* pinnate, 4–8 cm long, petiole up to 0.5 cm. *Stipules* membranous, silky outside. *Petiole and rachis* densely appressed-silky. *Leaflets* 12–18 pairs, suborbicular to elliptic, up to 5–8 by 4–5 mm, stiff and folded, pinnatifid to pinnatisect with 2–4 incisions on either side, long silky on both sides. *Flowering stems* up to 3 cm, with 1–4 flowers and some reduced leaves. *Hypanthium* hairy outside. *Epicalyx* leaves elliptic, 2–3 mm long, entire or apically notched, hairy outside. *Sepals* triangular, 2–3 mm

long, indumentum as epicalyx. *Petals* elliptic, 3–3.5 by 2–2.8 mm, yellow. *Stamens* 5, filaments c. 1.5 mm, anthers c. 0.7 mm long. *Torus* low, hairy. *Pistils* many, ovary glabrous, on hairy stalk, style lateral. *Achenes* c. 1 mm long, brown.

Distribution — New Guinea, only seen from Irian Jaya.

Habitat — Unknown, altitude 4000–4600 m.

Note — The species was collected on Mt Trikora in 1913 and on Mt Jaya in 1936. Remarkably it has not been re-collected during more recent explorations of these mountains by G.S.Hope, J.-M. Mangen and J. Raynal.

TRIBUS POTERIEAE

Herbaceous, rarely woody, plants with pinnate leaves. *Stipules* adnate to petiole. *Epicalyx* absent. *Petals* sometimes absent. *Pistils* several or only 1, superior, enclosed in *hypanthium*. *Ovule* 1, pendulous. *Achenes*, sometimes drupaceous. $x = 7$.

ACAENA

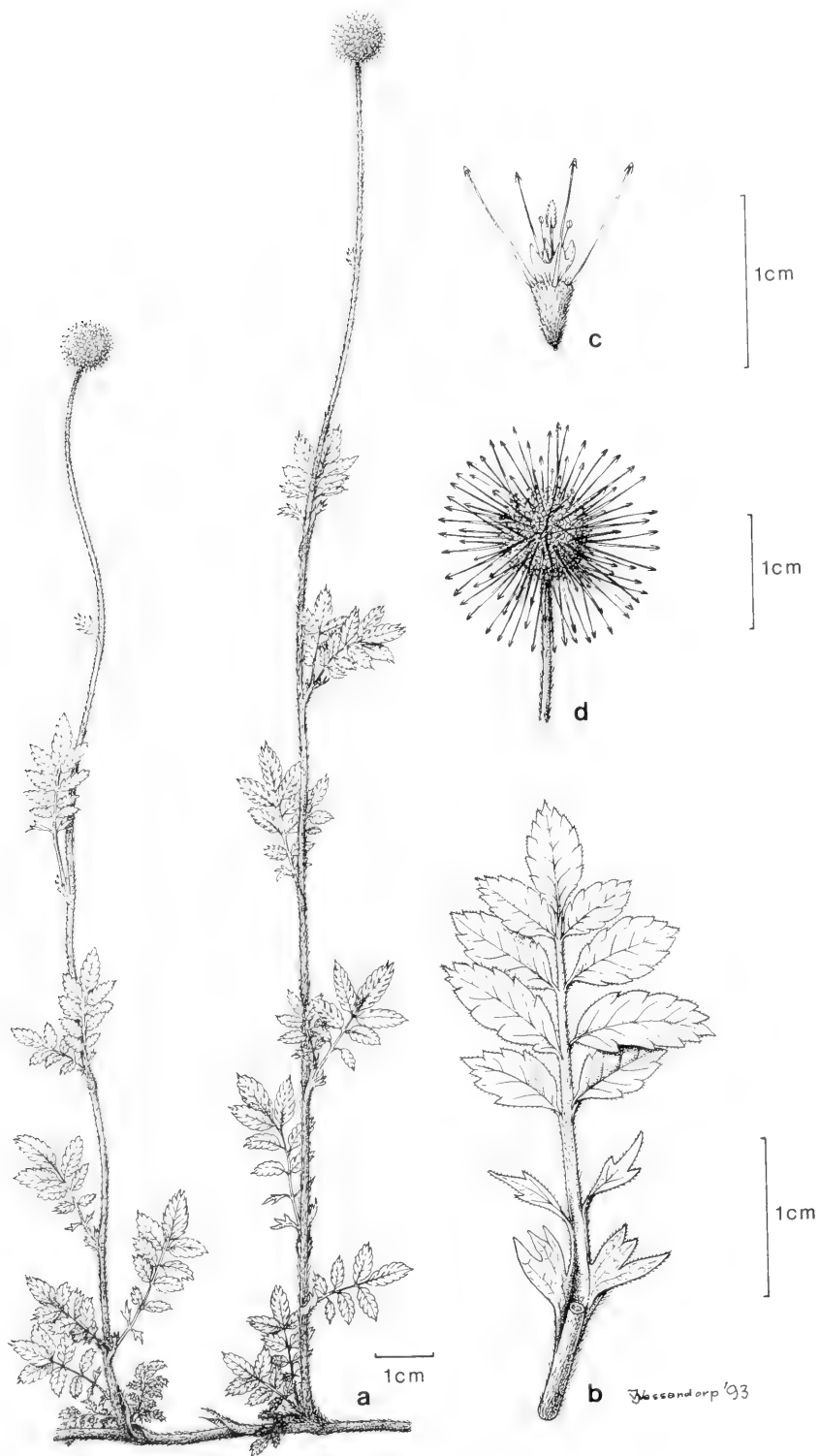
Acaena L., *Mant. Pl. alt.* (1771) 200; Bitter, *Bibl. Bot.* 74 (1911) 1–336. — Type species: *Acaena elongata* L.

Herbs, usually creeping, rarely suffrutescent. *Leaves* imparipinnate, rarely subdigitate. *Inflorescences* axillary or terminal, spicate or capitate. *Flowers* usually 4-merous, bisexual. *Hypanthium* \pm obconoid, narrowed at the throat, usually armed with few to many barbed spines. *Sepals* 3–7, usually 4, valvate, free or shortly connate. *Petals* absent. *Stamens* 1–8, often 4, episepalous. *Pistils* usually 1, sometimes 2–4, free; ovary 1-locular; style terminal, stigma plumose. *Achene(s)* remaining enclosed in *hypanthium*. — **Fig. 10.**

Distribution — About 40 species (or c. 150 when a much narrower species concept is followed), almost restricted to the Southern Hemisphere, most richly developed in South America, going northwards through Central America to California (1 species). Also in Hawaii (1 species), South Africa (2 species), in the Australian region (several species, in Australia, Tasmania, New Zealand and neighbouring islands, New Guinea), and on the subantarctic islands. In *Malesia* one species in New Guinea.

Acaena anserinifolia (J.R. & G. Forster) Druce, *Bot. Soc. Exch. Club Rep.* 1916, Suppl. 2 (1917) 602; Steenis, *Bull. Jard. Bot. Buitenzorg* III, 13 (1934) 241; P. van Royen, *Alpine Fl. New Guinea* 4 (1983) 2427. — *Ancistrum anserinifolium* J.R. & G. Forster, *Char. Gen. Pl.* (1776) 2, pl. 2, '*anserinaefolium*'. — Type: *Forster s.n.*, no exact locality.

Prostrate herbs, stems long-hairy. *Leaves* 2–4 (–9) cm long, petiole up to 0.5 (–1) cm. *Stipules* membranous, up to 1–1.5 cm long, the free tips leaflet-like, long-hairy. *Petiole and rachis* with long appressed hairs. *Leaflets* 4–6 pairs, elliptic to oblong-lanceolate, upper lateral ones largest, 7–11 (–18) by 2–5 (–10) mm, serrate, with long appressed hairs underneath. *Flowering stems* procumbent



or erect. *Inflorescence* a solitary, terminal, globose head, 5–8 mm diam. in anthesis, white, with 50–80 flowers, peduncle 2–9 cm, hairy, in fruiting stage head up to 2.5 cm diam. incl. the spines on the hypanthia. *Bracts* 7–10, membranous, forming an involucre close under the head, also some between the flowers. *Flowers* bisexual, (sub)sessile. *Hypanthium* obovoid, quadrangular in cross section, 1–2 mm long, with an ascending spine of 1–2 mm on each of the angles (often one or more missing), densely long- and stiff-hairy. *Sepals* 4, obovate to elliptic, up to 1.8 by 1 mm, erect, persistent. *Stamens* 2 (or 3), filaments up to 2 mm, anthers up to 0.5 mm long. *Pistil* 1, ovary spindle-shaped, glabrous, only the 1 mm long style protruding, stigma fimbriate. *Achene* enclosed in the enlarged hypanthium, the latter then obpyramidal, quadrangular or with 4 narrow wings, up to 3 mm long, densely hairy, the barbed spines up to 1 cm long, reddish to purple. — **Fig. 10.**

Distribution — Australia from Queensland to S Australia and Tasmania, New Zealand and nearby island groups; in *Malesia*: only in New Guinea.

Habitat — In New Guinea in edges of forest and shrubland, in open places like landslides and riverbanks, more rarely in subalpine grassland, altitude 1900–4100 m.

Ecology — Epizoochorous by means of the barbed spines. Certainly also anthropochorous.

Notes — *Acaena anserinifolia* is a complex species. Bitter, l.c., who certainly cannot be accused of irresponsible lumping, placed the many forms (19 varieties and subspecies) he recognized all in one species. For New Zealand Allan (Flora New Zeal. 1, 1961, 361) changed several of those varieties etc. into independent species, admitting that “the close relationship of these groups is undoubted.” He also remarked (l.c.: 363) that “fertile hybrids between them are \pm common, yet in the absence of hybridism they are true-breeding,” which seems to indicate that his species are actually ecotypes.

The description given here is based on New Guinean material only. This material is very homogeneous and matches well the Australian specimens seen.

AGRIMONIA

Agrimonia L., Sp. Pl. (1753) 448. — Type species: *Agrimonia eupatoria* L.

Perennial herbs with creeping rhizomes and erect leafy stems, usually hairy and often glandular. *Leaves* interruptedly imparipinnate. *Stipules* large. *Inflorescences* terminal, spike-like racemes. *Flowers* rather small, 5-merous, bisexual. *Hypanthium* \pm turbinate, apically armed with erect or patent, hooked bristles, throat almost closed by a dome-shaped disc with a central pore. *Sepals* persistent, connivent after anthesis. *Petals* yellow, rarely white. *Stamens* 5–numerous. *Pistils* 2, free; ovaries 1-locular; style terminal. Usually one *achene* developing, enclosed in the indurate, 10-ribbed, armed hypanthium, pericarp thin. — **Fig. 11.**

Distribution — About 15 species, in temperate regions and montane in the tropics, on the Northern Hemisphere, in S America and S Africa, one species in *Malesia* (Java).

Agrimonia nepalensis D. Don, Prod. Fl. Nepal. (1825) 229. — Type: *Hamilton s.n.*, Nepal.

Agrimonia blumei G. Don, Gen. Hist. Dichl. Pl. 2 (1832) 563, excl. specimens from Japan. — *Agrimonia suaveolens* auct. non Pursh (1814): Blume, Bijdr. (1826) 1113, excl. specimens from Japan. — *Agrimonia javanica* Jungh., Java 1

(1853) 664, nom. superfl., illeg.; Miq., Fl. Ind. Bat. I, 1 (1855) 370; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 241. — Type: probably *Reinwardt 1605* (or *1609?*), Tenger Mts. ***Agrimonia eupatoria*** L., p.p.: Koord., Exk. Fl. Java 2 (1912) 333; Backer & Bakh. f., Fl. Java 1 (1964) 519; Steenis, Mount. Fl. Java (1972) pl. 44-1.

Erect herbs, sparsely branched, up to 1 m, stems, rachises and petioles with long and short patent hairs, glandular. *Leaves* 8–16 cm long, petiole 1–5 cm. *Stipules* herbaceous, amplexicaul, 3 by 3 cm, deeply serrate, hairy and glandular outside. *Leaflets* up to 4 pairs, elliptic to oblong, 2–6 by 1–2 cm, intermediary leaflets 1–3 between primary ones, (very) small, all leaflets subsessile, deeply serrate, appressed-hairy and glandular, also patent hairs on midrib below. *Raceme* simple or branched at base, 15–30 cm, in lower part the flowers far apart. *Bracts* trifid to tripartite, up to 4.5 mm, bracteoles 2. *Pedicels* up to 2.5 mm. *Flowers* staying erect after anthesis. *Hypanthium* obconoid, 1–2 mm long, with 10 obtuse ribs going to the base but most distinct in upper part, appressed-hairy, under the sepals with many erect spines, those curved inwards at apex, up to 1.2 mm. *Sepals* 2–2.5 by 0.8–1 mm, appressed-hairy mainly on the 3 prominent nerves. *Petals* elliptic to obovate, 2.5–3.5 by 1.5–2 mm, yellow. *Stamens* c. 10, filaments up to 2.8 mm, anthers consisting of 2 subglobular thecae. *Ovary* 1 mm, style up to 2 mm. *Achenes* usually 1 per flower, fruiting hypanthium 2.5–3 by 3–4 mm, distinctly ribbed, spines all erect and the larger ones about as long as the calyx. – **Fig. 11.**

Distribution – Continental SE Asia (Nepal, Assam, Burma, S China, N Thailand, Laos, Vietnam); in *Malesia* only on some mountains in C and E Java.

Habitat – Montane, open, often grassy habitats, altitude c. 1200–2200 m.

Notes – The Java specimens of *Agrimonia* cannot be separated from the continental *A. nepalensis* D. Don: there is not a single difference.

Some authors place *A. nepalensis* in synonymy under *A. pilosa* Ledeb. (e.g. Nakai, Bot. Mag. Tokyo 47, 1933, 245; Hara & Kurosawa, J. Jap. Bot. 43, 1968, 392; Yü & Li, Acta Phytotax. Sin. 15, 1977, 89; Purohit & Panigrahi, J. Jap. Bot. 58, 1983, 289) without, however, giving an opinion about the disposition of the plants from Java. Other specialists keep the two species mentioned above separate (Juzepchuk, Fl. U.S.S.R. 10, 1941, 415; Vidal, Fl. Camb., Laos & Vietnam 6, 1968, 134; Skalicky, in litt., 1969). On the basis of differences in stipules, petals, and indumentum, and in the absence of a full modern monographic treatment of the genus over its whole area I prefer to keep the species separate.

To place *A. nepalensis* and *A. blumei* within a then almost all-embracing species *A. eupatoria* L., as practised in some treatments for Java, does not seem a sensible classification to me. The most

conspicuous difference between series *Eupatoria* Juz. and *Pilosae* Juz. is that in the latter the ‘fruits’ (fruiting hypanthia) remain erect after anthesis.

There is in BO (and to a lesser degree also in L) a fair amount of old herbarium material from Java, but the species has seemingly not been re-collected since 1941.

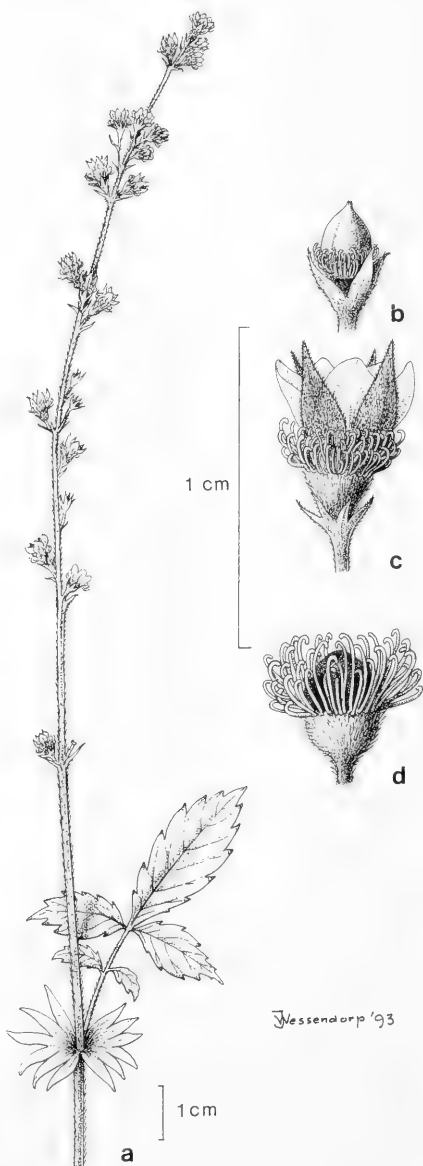


Fig. 11. *Agrimonia nepalensis* D. Don. a. Top of flowering stem; b. bud; c. flower; d. hypanthium in fruiting stage (Reinwardt 1605).

SANGUISORBA

Sanguisorba L., Sp. Pl. (1753) 116. — Type species: *Sanguisorba officinalis* L.

Perennial herbs or shrubs, unarmed. *Leaves* often in rosettes, imparipinnate. *Flowers* in terminal spikes or heads on usually long and slender peduncles, 4-merous, bi- or unisexual. *Hypanthium* urceolate, constricted at apex, persistent. *Sepals* deciduous. *Petals* absent. *Stamens* 2–50. *Pistils* 1 or 2, rarely 3, free; ovaries 1-locular; style terminal, with penicillate stigma. *Achenes* included in hardened hypanthium.

Distribution — About 20 species, North temperate.

Note — Nordborg, Opera Bot. Lund 11 (2) (1966) 1–103, united not only *Sanguisorba* L. and *Poterium* L. pro max. p., which is often done, but also *Poteridium* Spach, *Dendropoterium* Svent., and *Marcetella* Svent. The description given here is in accordance with this large circumscription.

Sanguisorba minor Scop., Fl. Carn. ed. 2, 1 (1771) 110; Backer & Bakh. f., Fl. Java 1 (1964) 519. — Type: Nordborg 8040, Spain, neotype, see Nordborg, Opera Bot. Lund 16 (1967) 98.

Herb, 0.5 m, stems faintly soft-hairy. *Leaves* 5–9 cm long. *Leaflets* 3 or 4 pairs, 1.5–2.5 cm long. *Heads* globose, up to 1.5 cm diam., with up to 15 crowded flowers, peduncle up to 10 cm long. *Flowers* sessile, bisexual (rarely male) in lower part, female in upper part of head. *Hypanthium* 4-

ribbed. *Sepals* imbricate. *Stamens* 10–30 in male and bisexual flowers, filaments up to 8 mm. *Pistils* 2. *Achenes* glabrous, pericarp bony in upper part.

Distribution — W, C and S Europe, N Africa, W Asia, introduced and naturalized in N America. According to Backer & Bakhuizen f., l.c., the species is in the mountains of Java sometimes cultivated as a pot-herb. I have seen only one sheet of such a cultivated plant. Also in Europe the leaves are (were?) used as a vegetable, in soups, and in salads.

TRIBUS ALCHEMILLEAE

Herbaceous or shrubby plants with simple, but often deeply palmately incised leaves. Stipules adnate to petiole. Epicalyx present. Pistils few, superior, enclosed in hypanthium. Ovule 1, basal. Achene(s) enclosed in hardened hypanthium. $x = 8$. Only genus: *Alchemilla* s.l., sometimes divided into several genera.

ALCHEMILLA

Alchemilla L., Sp. Pl. (1753) 123. — Type species: *Alchemilla vulgaris* L.

Perennial or annual, erect or prostrate herbs or suffrutices. *Leaves* simple, usually petioled, \pm orbicular in outline, palmately to pedately nerved and palmately incised, folded in bud. *Stipules* rather large. *Flowers* sometimes solitary, usually in cymes, corymbs, or racemes, small, 4-merous (more rarely 5-merous), bisexual. *Hypanthium* \pm urceolate, throat almost closed by the disc. *Epicalyx* leaves usually smaller than sepals, rarely 0. *Sepals* valvate. *Petals* absent. *Stamens* 1, 2, or 4, rarely 5, inserted outside or inside the disc, epi- or alternisepalous, short, pollen in many species sterile (apogamy). *Pistils* 1–4

(–10), free; ovaries sessile or shortly stalked, 1-locular; style ventral or subbasal, protruding through the disc. *Achenes* 1–4, remaining enclosed in indurate hypanthium, pericarp bony to membranous. — **Fig. 12.**

Distribution — Subcosmopolitan, in all continents. Many species synanthropic and areas not always entirely natural. In *Malesia* one species (Java).

Notes — The number of species may be about 200–400 but as in other apogamous groups it depends very much on the species concept used. Over 300 microspecies have been described in Europe.

For the description given above, a broad delimitation of the genus is used, i.e. including *Aphanes*, *Lachemilla*, and *Zygalthemilla*.

Alchemilla villosa Jungh., Nat. Geneesk. Arch. Ned. Ind. 2 (1845) 46; Java 1 (1853) 596; Miq., Fl. Ind. Bat. I, 1 (1855) 369; Backer & Bakh.f., Fl. Java 1 (1964) 518; Steenis, Mount. Fl. Java (1972) pl. 44-2. — Type: *Junghuhn s.n.*, Java, lecto in L, sh. 908.195-1315.

Alchemilla dendroidea Zoll. & Mor. in Zoll., Nat. Geneesk. Arch. Ned. Ind. 1 (1844) 484, nomen, in obs.

Alchemilla vulcanica Zoll. & Mor. in Zoll., Nat. Geneesk. Arch. Ned. Ind. 2 (1845) 587, nomen, in obs., non Schlechtend. & Cham. (1830).

Perennial herbs, main stems ± decumbent, older parts covered with remains of stipules and petioles, lateral stems prostrate to sub-erect, up to 1 m, not rooting (?), stems and petioles with patent long hairs. *Stipules* of the leaves on the main stems membranous, those of the leaves of the long shoots herbaceous, up to c. 1 cm long, shortly adnate, shortly connate at opposite side of stem, long-hairy outside. *Leaves* very variable in size, blades from 6 by 8 mm to 5 by 8 cm, petioles 1–20 cm. *Leaf-blades* reniform, (5–)7–9-fid, base deeply incised, serrate, the apical tooth of each lobe normally shorter than adjacent ones, pedately nerved, both sides with semi-appressed hairs. *Inflorescences* axillary, sympodially stretched cincinni, usually simple, 2–15 cm long, up to c. 12 flowers, peduncle up to 5 cm. *Bracts* 2 with each flower, herbaceous. *Flowers* 4-merous. *Hypanthium* narrowly infundibuliform, 1–1.5 by 0.8–1 mm, densely hairy outside. *Disc* almost closing throat of hypanthium, intrastaminal, cushion-shaped. *Epicalyx* leaves apart, ovate to elliptic, 0.8–1.2 by 0.5–0.8 mm, hairy outside. *Sepals* ovate-triangular, 1.2–1.5 by 0.8–1 mm, indumentum as epicalyx. *Stamens* 4, alternisepalous, filaments 0.5 mm, anthers c. 0.2 mm, falling early. *Pistil* 1, ovary glabrous, shortly stalked, style subbasal. *Achene* enclosed in endurated, slightly enlarged hy-

panthium, ovoid, c. 1.2 mm long, style persistent, pericarp bony, smooth.

Distribution — *Malesia*: Java, from Mt Papan-dayan eastwards on many mountains.

Habitat — Grassy places, also in light shade (*Casuarina* forest), found at altitudes from 2100 to 3300 m.

Note — The most recent subdivision of the genus as a whole is to be found in Rothmaler's paper in Fedde Rep. 40 (1936) 208–212. Rothmaler did not place *A. villosa* and its relative from India and Sri Lanka, *A. indica*, in section *Brevicaules* to which the bulk of the Eurasian species belong, but in section *Longicaules* which – apart from the two Asian species – only contains species from Africa and Madagascar.

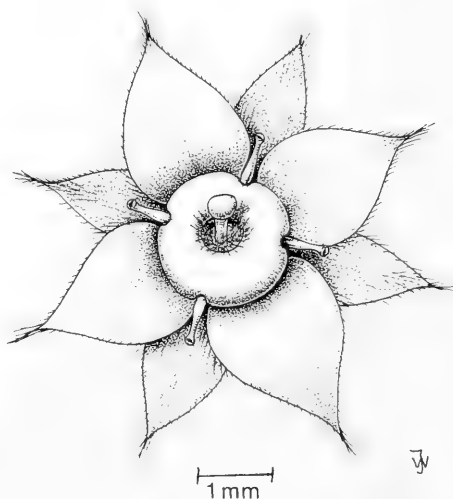


Fig. 12. *Alchemilla villosa* Jungh. Flower (Holst-voogd 295).

TRIBUS ROSEAE

Woody plants with pinnate leaves. Stipules adnate to petiole. Epicalyx absent. Pistils many, superior, enclosed in hypanthium. Ovules 1 (or 2), pendulous. Achenes enclosed in fleshy hypanthium. $x = 7$. Only genus: *Rosa*.

ROSA

Rosa L., Sp. Pl.(1753) 491; Kalkman, Blumea 21 (1973) 281. — Type species: *Rosa centifolia* L. See, however, Taxon 41 (1992) 568 where *R. cinnamomea* L. is proposed as the type species.

Erect, climbing, or prostrate shrubs, nearly always armed with straight or curved prickles, often with glands. *Leaves* imparipinnate, leaflets pinninerved, usually serrate. *Stipules* adnate (rarely, not in Malesia: leaves unifoliolate without stipules). *Flowers* solitary and terminal or in terminal thyrses or racemes, large and showy, bisexual, nearly always 5-merous, cultivars often double. *Hypanthium* usually globular to urceolate, throat almost closed by a thickened annular disc. *Sepals* imbricate, often foliaceous and at least the outer ones often pinnately incised, persistent or caducous. *Petals* imbricate, different shades of red, white, or yellow. *Stamens* many. *Pistils* many, rarely few; ovaries superior, shortly stalked or sessile, free, included in the hypanthium, 1-locular; styles terminal or lateral, free or with their upper parts coherent to connate, protruding through the hole in the disc; ovule 1, rarely 2, pendulous. *Fruits* achenes with usually bony pericarp, included in the accrescent, \pm fleshy, coloured hypanthium (hip). *Seed* with thin testa; endosperm absent. — **Fig. 13.**

Distribution — Probably more than 100 species, in temperate to subtropical regions of the Northern Hemisphere, some in the montane parts of the tropics. Ornamentals with a long history of hybridization and with innumerable cultivars of untraceable origin. In *Malesia* 2 species indigenous in Luzon, Philippines.

Uses — The modern cultivated roses are almost all complex hybrids. Any of these may be found cultivated also in SE Asia but they never come beyond the local market. See D.O.Wijnands in E.Westphal & P.C.M.Jansen (eds.), Plant Res. SE Asia (PROSEA Handbook). A selection (1989) 240–241.

Note — Occasionally cultivated roses may run wild. See Backer & Bakh.f., Fl. Java 1 (1964) 519–520 and Kalkman, Blumea 21 (1973) 281–291. Only the truly wild species are treated here.

KEY TO THE SPECIES

- 1a. Apical leaflets up to 4 cm long. Flowers 7–30, rarely more, in a terminal raceme or thyrses. Styles hairy 1. *R. luciae*
- b. Apical leaflets up to 1.5 cm long. Flowers usually solitary, terminal on leafy laterals, rarely also 1 or 2 flowers in the upper leaf-axil(s). Styles glabrous
2. *R. transmorrissonensis*



1. *Rosa luciae* Franch. & Rochebr. ex Crépin, Bull. Soc. Roy. Bot. Belg. 10 (1871) 324; Kalkman, Blumea 21 (1973) 284, f. 2. — Type: Savatier specimen in herb. Franchet, Japan.

Rosa wichuraiana Crépin, Bull. Soc. Roy. Bot. Belg. 15 (1876) 204, nomen; *ibid.* 25 (1887) 189, descr. — *Rosa luciae* var. *wichuraiana* Koidz., J. Coll. Sc. Imp. Univ. Tokyo 34, art. 2 (1913) 232. — Type: not indicated.

Rosa philippinensis Merr., Philipp. J. Sc. 17 (1921) 260, incl. var. *depauperata* Merr., l.c.; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 243. — Type: Elmer 5794, holo; several paratypes; all Luzon.

Suberect to straggling or \pm climbing shrubs, up to 4 m. Twigs (scarcely) glandular, otherwise mostly glabrous, prickles 2 under each leaf, up to 4 mm usually no other prickles present. Leaves 4–10 (–12) cm long, free part of petiole up to 1 (–1.5) cm long. Stipules adnate over (3.5)–8–11 mm, wings 0.7–1.5 mm wide, free tips 1–2.5 mm long, margin dentate and with stalked glands. Leaflets 7–9, lateral ones elliptic to elliptic-ovate or elliptic-oblong, up to 12–32 by 7–20 mm, apical one larger than upper lateral ones, margin serrate, glabrous or with few hairs, lateral leaflets subsessile, apical petiolules up to 1 cm. Flowers 7–30 or more in a terminal raceme or thyrses, the lower flowers or partial inflorescences in the axils of small leaves. Bracts linear or with expanded apex. Pedicels 1–2.5 cm long, glandular, otherwise glabrous or slightly hairy. Closed flowerbuds globular, mucronate to abruptly acuminate, flowers strongly fragrant. Hypanthium ellipsoid to obovoid, 3–4.5 by 2–3.5 mm in anthesis, outside glandular, with few hairs or glabrous, long-silky inside. Sepals reflexed during and after anthesis, caducous, ovate to elliptic-ovate, acuminate, (6.5)–8–11 by 2.5–4 mm including acumen of up to 4 mm, 1–2 side-lobes on exposed margins, glandular and sparsely hairy outside. Petals (broadly) obovate, 11–18 by 9–11 mm, retuse, white. Stamens 100 or more, filaments up to 7 mm, anthers up to 1.5 mm long. Pistils 12–25, ovary with a plume of long stiff hairs on one side at apex, styles 5.5–7 mm long, cohering, hairy. Hips globular, 6–8 (–10) mm, smooth, bluish-black. Achenes angular ovoid, c. 4.5 mm long, with hairs on one side, pericarp thick, woody. — Fig. 13.

Distribution — Japan, Korea, Ryukyu Is., E China, Taiwan; in Malesia: Philippines (Luzon: several places in the Mountain Prov.).

Habitat — Hardly any information available. According to Merrill, Enum. Philipp. Flow. Pl. 2 (1923) 231, growing in thickets, 1200–1700 m altitude.

Note — The description given only pertains to the specimens from Luzon and does not reflect the existing variation in the entire area.

2. *Rosa transmorrisonensis* Hayata, Ic. Pl. Formos. 3 (1913) 97; Kalkman, Blumea 21 (1973) 284, f. 1. — Type: Mori s.n., Mt Morrison.

Rosa luzoniensis Merr., Philipp. J. Sc. 17 (1921) 259; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 243. — Types: Santos BS 31876, Mearns 4300, McGregor BS 8336, Pauai.

Climbing shrubs. Twigs thin, glabrous, prickles 2 under each leaf, up to 7 mm. Leaves up to 5 cm, glabrous, free part of petiole 1–4 mm long. Stipules adnate over c. 5 mm, wings c. 1.2 mm wide, free tips c. 3 mm long, margins fimbriate and with glandular teeth. Leaflets (5 or) 7, lateral ones elliptic, apical one larger than lateral ones, 8–15 by 4–6 mm, margin finely serrate, lateral petiolules up to 1 mm, apical one up to 4 mm. Flowers solitary, terminal on short and leafy laterals, rarely also 1 or 2 in the upper leaf-axils. Pedicels up to 1 cm long, glabrous, not glandular. Closed flowerbuds globular, mucronate. Hypanthium ellipsoid, c. 4 by 2.5 mm, glabrous and without glands outside, hairy inside. Sepals reflexed in anthesis, ovate to elliptic, acuminate, 6–7 by 2.5–3.2 mm not including the 1–3 mm long acumen, glandular and with 1–3 side-lobes on the exposed margins, glabrous outside except parts covered in bud. Petals obovate, up to 11 mm long, retuse, white. Stamens c. 100, filaments up to 5.5 mm, anthers c. 1.2 mm long. Pistils c. 12, ovary spindle-shaped, with a plume of long silky hairs near apex, styles c. 5 mm long, firmly cohering, glabrous. Hips and achenes not seen.

Distribution — Taiwan; in Malesia: Philippines (Luzon: Mountain Prov.).

Habitat — In thickets, altitude c. 1200 m and higher.

Fig. 13. *Rosa luciae* Crépin. a. Flowering branch, $\times 1$; b, c. flower buds, $\times 3.5$; d. flower halved lengthwise, $\times 3.5$; e. infructescence, $\times 1$ (a: Ramos & Edaño BS 37920; b, c: Jacobs 7595; c, d: Conklin & del Rosario PNH 72379).

TRIBUS MALEAE

Woody plants. Leaves simple, rarely pinnate. Stipules on the very base of the petiole, free or connate. Hypanthium hollowed, entirely or partly connate with pistils, becoming fleshy. Epicalyx absent. Carpels (1-)2-5, partly or entirely connate with each other. Ovules 2, rarely 1, ascending. Pome with bony or membranous endocarp, or multipyrenous drupe with woody endocarps. $\times = 17$. — **Figs. 14, 15.**

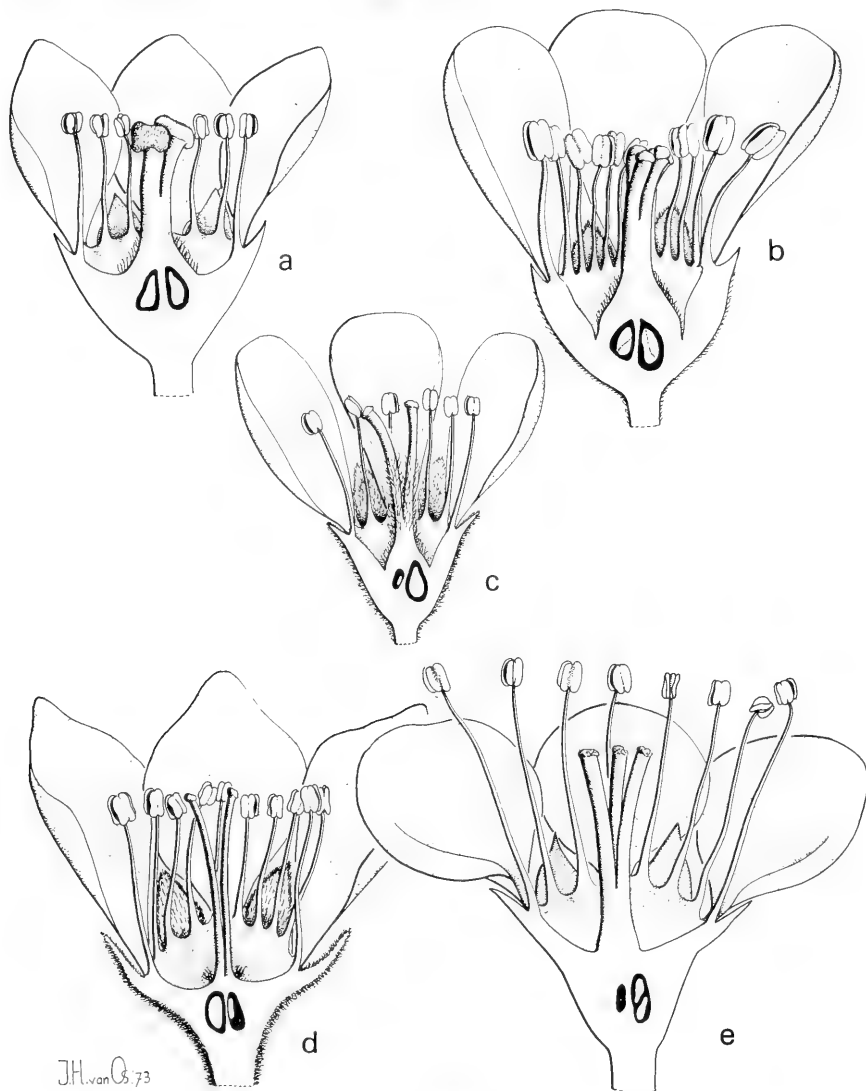


Fig. 14. Flowers of tribus Maleae, representative Malesian species, slightly idealized. a. *Photinia integrifolia* Lindley; b. *Photinia davidiana* (Decne.) Cardot; c. *Eriobotrya bengalensis* (Roxb.) Hook. f.; d. *Rhaphiolepis philippinensis* (Vidal) Kalkman; e. *Micromeles corymbifera* (Miq.) Kalkman (a: Meijer 1669; b: Fuchs & Collenette 21455; c: Krukoff 4086; d: Sulit PNH 12452; e: Meijer 3466).

Note — The tribe as recognized here confirms to the subfamily *Maloideae* of most classifications. In that group often two taxa are recognized, e.g. as *Sorbeae* and *Crataegeae*. Of the genera in Malesia only the non-indigenous *Cotoneaster* and *Pyracantha* belong to the latter group. Iketani & Ohashi in a recent paper [J. Jap. Bot. 66 (1991) 319–351] recorded the anatomical structure of the fruits of ‘*Sorbeae*’ and drew conclusions about evolutionary trends and phylogenetic relationships. The inclusion of *Stranvaesia* in *Photinia* is supported by them, *Micromeles* is included in *Aria*, and *Pourthiaea* is considered to be a genus distinct from *Photinia* [see also Iketani & Ohashi, J. Jap. Bot. 66 (1991) 352–355).

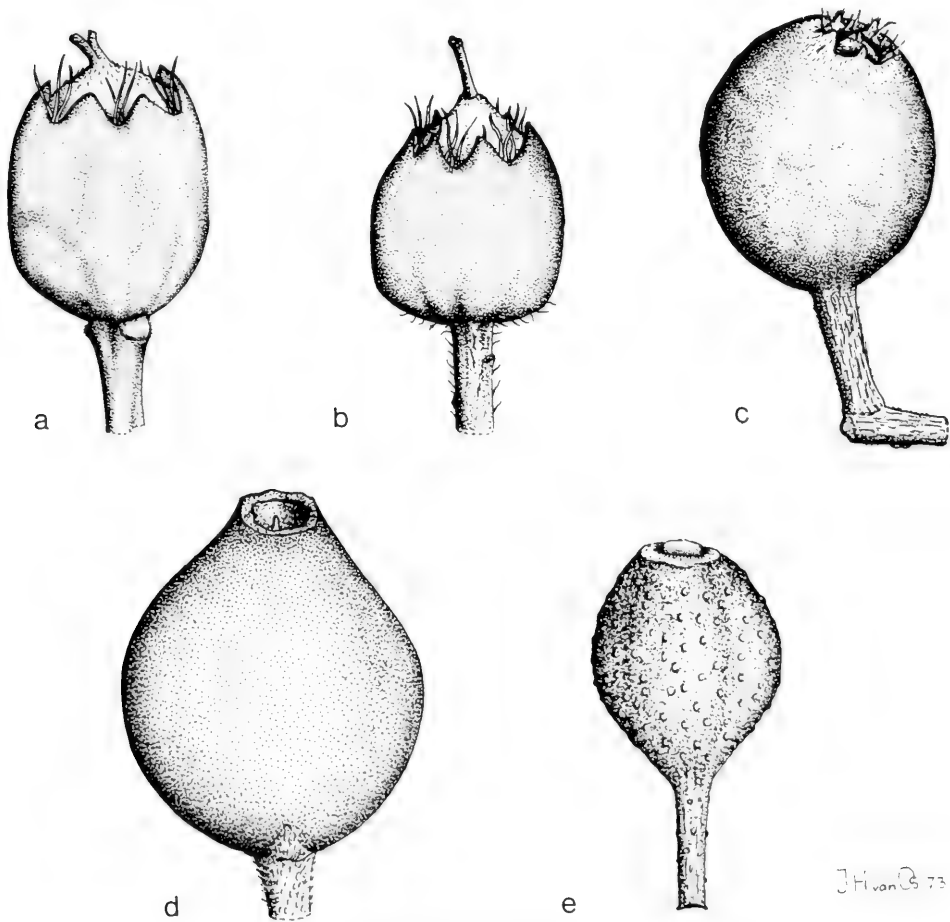


Fig. 15. Fruits of tribus Malceae, representative Malesian species. a. *Photinia integrifolia* Lindley; b. *Photinia davidiana* (Decne.) Cardot; c. *Eriobotrya bengalensis* (Roxb.) Hook. f.; d. *Rhaphiolepis philippinensis* (Vidal) Kalkman; e. *Micromeles corymbifera* (Miq.) Kalkman (a: Hochreutiner 908; b: Fuchs & Collenette 21431; c: Thorenaar 101; d: Sulit PNH 7760; e: Rahmat Si Boeea 10727).

COTONEASTER

Cotoneaster Medikus, Philos. Bot. 1 (1789) 154. — Type species: *Cotoneaster vulgaris* Lindley (*Mespilus cotoneaster* L.).

Evergreen or deciduous shrubs or small trees. *Twigs* not thorny. *Carpels* 2–4, free from each other but connate with the hypanthium, ovary semi-inferior, styles free, ovules 2. *Fruits* crowned by persistent sepals, containing 2–4 pyrenes.

Distribution — About 50 species [261 species according to Robertson et al., Syst. Bot. 16 (1991) 391], centred in E Asia, many species cultivated as ornamentals all over the world.

Cotoneaster lacteus W.W. Smith, Notes Roy. Bot. Gard. Edinb. 10 (1917) 23 ('*lactea*'). — Types: *Forrest 10419, 11338, 12720*, China.

Shrubs or trees up to 7 m. *Twigs* hairy when young, glabrate. *Leaves* elliptic, 5–6 by 2.5–4 cm, base acute, margin entire, apex rounded and mucronate, coriaceous, with 6–8 pairs of nerves, not terminating in the margin, when young sparsely hairy above and densely short-woolly below, when mature sparsely hairy to glabrous. *Petiole* up to 8 mm long. *Stipules* narrowly triangular, c. 6 by 0.7 mm, hairy outside. *Inflorescence* a terminal, umbel-shaped, compound raceme, the lower 1 to 3 branches in the axils of (reduced) leaves, c. 2.5 cm high, 5 cm wide, rachises densely hairy in anthesis and still hairy in fruit, pedicels up to 4 mm long, densely hairy. *Hypanthium and sepals* densely hairy outside, upper rim of hypanthium free from ovary. *Petals* orbicular, spreading in anthesis, white. *Stamens* c. 20. *Pistils* 2, in their basal half connate with the hypanthium, free from each other and long-hairy on the free top, styles terminal. *Fruits* obovoid, c. 6 by 5 mm when dry

(8 by 6 mm when living), when developing the free rim of hypanthium and sepals closing around the top, with 2 stones protruding at the top when ripe, reddish.

Distribution — Three specimens collected by J. Sterly in the Gembogl Subprovince, Papua New Guinea, said to be introduced there from Goroka, also in Chimbu Province. Cultivated in these places as an ornamental, but also running wild.

Habitat — At altitudes from 1980 to 2650 m.

Ecology — Fruits eaten and propagated by birds (*Sterly 1751*).

Notes — In this predominantly apogamous genus which, moreover, contains a large number of cultivars, species delimitation is difficult. I am by no means certain that the identification of the three specimens available is correct, but it did not seem useful to me to pursue the matter further.

J.M.B. Smith, Science in New Guinea 16 (1990) 13–21, reported the presence in 1989 of *Cotoneaster glaucophyllus* on Mt Wilhelm, Papua New Guinea, as planted and growing well. I did not see a specimen from that locality but the same species may be involved as in the other places.

ERIOBOTRYA

Eriobotrya Lindley, Trans. Linn. Soc. Lond. 13 (1921) 102; Blume, Bijdr. (1826) 1102; Hutch., Gen. Flow. Pl. 1 (1964) 214; Vidal, Fl. Camb., Laos & Vietnam 6 (1968) 60; Fl. Thailand 2 (1970) 42; Kalkman, Blumea 21 (1973) 430. — Type species: *Eriobotrya japonica* (Thunb.) Lindley.

Unarmed trees or shrubs, evergreen. *Leaves* simple, margin dentate or entire, main nerves terminating in the margin. *Stipules* free or intrapetiolarly connate. *Inflorescence* a terminal, compound raceme. *Flowers* bisexual, 5-merous. *Hypanthium* obconoid, elongated above the ovary. *Sepals* persistent. *Petals* clawed, white. *Stamens* 15–40. *Ovary* semi-inferior to inferior, the hairy top of the connate carpels free from the hypanthium,

2–5-celled, styles as many as cells, usually connate at base, ovules 2 per cell. *Fruit* a pome, crowned by the persistent sepals, mesocarp fleshy or with many stone-cells, endocarps free from each other, membranous, each containing one seed. *Seeds* large, testa thin but hard, endosperm absent, embryo with thick cotyledons. — **Figs. 14c, 15c.**

Distribution — About 20 species, from Himalayan region to Japan and throughout SE Asia southwards to Sumatra, Malaya and Borneo. Only one species indigenous in *Malesia*.

KEY TO THE SPECIES

1a. Leaves soon glabrate, practically glabrous when mature, with 7–10 pairs of nerves. Stipules free. Petiole 1.5–2.5 cm. Ovary semi-inferior, 2(–3)-celled

1. *E. bengalensis*

b. Leaves tardily glabrescent, still densely woolly when mature, with 10–22 pairs of nerves. Stipules intrapetiolarly cohering or connate. Petiole up to 1 cm. Ovary inferior, 5-celled 2. *E. japonica*

1. *Eriobotrya bengalensis* (Roxb.) Hook. f., Fl. Brit. India 2 (1878) 371; Ridley, Fl. Mal. Penins. 1 (1922) 681; Prance & Whitmore in Tree Fl. Malaya 2 (1973) 326, f. 2. — *Mespilus bengalensis* Roxb., Fl. Ind. 2 (1832) 510. — Type: Wallich 668/2.

Trees up to 27 m, sometimes shrubs, rarely buttressed, with spreading branches having flat foliage ('terminalian' branching), bark rough and lenticellate, white or grey. *Twigs* densely hairy when young, rapidly glabrescent. *Leaves* oblong to oblong-lanceolate, 6–17 by 2–6.5 cm, base gradually tapering, margin shallowly serrate, apex acute to shortly acuminate, coriaceous, with 7–10 pairs of nerves, each often with one stronger side-nerve, those and the primary nerves terminating in the marginal teeth, venation transverse, almost glabrous when mature but with a woolly indumentum on midrib and nerves when young, red when young and also when old. *Petiole* 1.5–2.5 cm, dark. *Stipules* caducous, triangular, up to c. 4 by 1 mm, free, ciliolate, sometimes large and semi-foliaceous, up to 14 by 4 mm. *Inflorescence* a terminal compound raceme with up to 12 laterals, the lowermost of those in the axils of (reduced) leaves, upper ones in axils of bracts, the panicle up to 14 cm long, peduncle very short, lower laterals up to 12 cm, pedicels 2–3(–5) mm long, densely hairy as are all other axes in the panicle. *Flowers* fragrant. *Hypanthium* 1.5–2.5 mm high, densely hairy outside. *Sepals* triangular, 2–2.5 by 1–1.5 mm, patent to reflexed during anthesis, densely hairy outside. *Petals* ovate to broadly obovate, 4–4.5 by 2–4.5 mm, reflexed in anthesis, with hairs at base inside,

otherwise glabrous, white. *Stamens* c. 20, filaments up to 3 mm, glabrous, anthers 0.6–0.8 mm long. *Ovary* inferior when young, later semi-inferior, 2(–3)-celled (see Note), long and densely hairy on top, styles shortly connate at base, 2–2.5 mm long, hairy in the lower part. *Fruits* globular, 10–15 by 9–15 mm (in dry state), exocarp more or less hairy, grey-green when young, reddish when ripe, mesocarp hard and gritty, endocarps firm-membranous. *Seeds* 1 or 2 per fruit, with thin papery testa. — **Figs. 14c, 15c.**

Distribution — SE Asia from Eastern part of Himalayas to Vietnam and West Malesia (Sumatra, Malaya incl. offshore islands, Bangka?, Borneo).

Habitat — Primary forest, often on limestone, found from sea-level up to 1200 (to over 1500) m altitude.

Ecology — Often on limestone, see also Chin See Chung, The limestone flora of Malaya (1973) 430.

Note — One specimen seen had consistently 5 styles, but this is quite exceptional.

2. *Eriobotrya japonica* (Thunb.) Lindley, Trans. Linn. Soc. Lond. 13 (1821) 102; Backer & Bakh. f., Fl. Java 1 (1964) 512. — *Mespilus japonicus* Thunb., Fl. Japon. (1784) 206. — Type: Thunberg s.n., Japan.

Small trees. *Twigs* rather stout, rough. *Leaves* more or less crowded at twig ends, oblong to lanceolate, 12–28 by 3.5–8 cm, margin shortly dentate in upper part, coriaceous, with 10–22 pairs of nerves, woolly above when very young but soon

glabrate, densely woolly and tardily glabrescent below. *Petiole* 4–10 mm long. *Stipules* intrapetio-
lar, cohering or connate into a 2-topped scale, up
to 1 cm long. *Inflorescence* a compound raceme,
15–20 cm long, peduncle short, pedicels very
short. *Flowers* rather large, very hairy. *Sepals* per-
sistent. *Petals* long remaining, white. *Ovary* infe-
rior or almost so, the densely hairy top free from
the hypanthium, 5-celled, styles (practically) free,
hairy at base. *Fruits* globular to ovoid, up to 8 cm
diam. but usually (much) smaller, exocarp hairy,
yellow to orange, mesocarp juicy, endocarps mem-

branous. *Seeds* 2 or 3, large, with firm, glabrous,
brown testa.

Distribution — Native in SE China, there and
in Japan cultivated for many years. Now through-
out the tropics and subtropics cultivated as a fruit
tree. In *Malesia*: cultivated in home gardens, not
commercially, at medium altitudes.

Uses — The juicy fruits (*loquat*) are eaten raw
and made into jam. See Nguyen Tien Hiep &
E.W.M. Verheij in E.W.M. Verheij & R.E. Coronel
(eds.), *Edible fruits and nuts*, Plant Res. SE
Asia (PROSEA Handbook) 2 (1991) 161–164.

MALUS

Malus Miller, Gard. Dict. (1754). — Type species: *M. sylvestris* Miller (*Pyrus malus* L.).

Trees or shrubs, unarmed or with thorns, mostly deciduous. *Leaves* simple, lobed or
toothed. *Flowers* in few-flowered, simple racemes. *Hypanthium* with a free rim above the
ovary, the rim persistent or rupturing after anthesis. *Ovary* inferior, carpels completely ad-
nate with the hypanthium and without exposed free top, 3–5-celled, styles connate at base.
Fruit a pome, mesocarp fleshy, in most species without stone cells, endocarp cartilaginous.

Distribution — About 50 species in Eurasia and N America. In *Malesia* only a culti-
vated species.

Malus domestica Borkh., Hand. Forstbot. 2
(1803) 1272. — *Malus sylvestris* Miller. —
Malus pumila Miller.

Small trees, up to 10 m. *Twigs* hairy when
young. *Leaves* elliptic-ovate, 4–13 by 3–7 cm,
base rounded, margins serrate, apex acute, with 3–6
pairs of nerves, usually hairy underneath. *Inflores-
cence* a simple raceme, terminal on short shoots.
Hypanthium hairy outside. *Sepals* persistent on
the fruit. *Petals* white to pinkish. *Ovary* 4- or
5-celled, inferior, ovules 2 per cell. *Fruit* a pome,
globular to obovoid, exocarp glabrous, variously
coloured, mesocarp fleshy, without stone cells, en-
docarp leathery to bony. *Seeds* usually 2 per cell.

Distribution — Originated in West Asia, now

spread over the entire world. In *Malesia*: cultivated
in E Java, Timor, the Philippines, and probably
some other islands.

Uses — See Surachmat Kusumo & E.W.M.
Verheij in E.W.M. Verheij & R.E. Coronel (eds.),
Edible fruits and nuts, Plant Res. SE Asia (PROSEA
Handbook) 2 (1991) 200–203 for a review of the
cultivation of the apple in Malesian countries.

Note — The name accepted pertains to the culti-
vated apple which is supposed to be derived from
wild *Malus pumila* and several other species hybrid-
ized with it. Since the genetic make-up of its
many cultivars cannot be ascertained, a separate
specific epithet seems warranted, although other
ways of reasoning may lead to the acceptance of
one of the other names mentioned above.

MICROMELES

Micromeles Decne., Nouv. Arch. Mus. Paris 10 (1874) 168; Kalkman, Blumea 21 (1973)
437. — *Pyrus* L. sect. *Micromeles* Hook. f., Fl. Brit. India 2 (1878) 377. — *Sorbus* L.
sect. *Micromeles* Rehder, Manual Cult. Trees & Shrubs (1927) 382; Vidal, Fl. Camb.,
Laos & Vietnam 6 (1968) 24. — Type species: not designated.
Aria (Pers.) Host, Fl. Austral. 2 (1831) 7, p.p.: Robertson et al., Syst. Bot. 16 (1991) 389.

Unarmed trees or shrubs, deciduous. *Leaves* simple, with the main nerves terminating in the serrate margin. *Stipules* free. *Inflorescence* a terminal, panicle-shaped, compound raceme. *Flowers* bisexual, 5-merous. *Hypanthium* obconoid, elongated above the ovary, the free part transversely rupturing after anthesis and falling with sepals and other flower-parts, its inside covered with a disc. *Stamens* c. 20. *Ovary* inferior, apex covered by the hypanthial disc, 2–5-, most often 3-celled, styles as many as cells, usually connate at base, ovules 2 per cell. *Fruit* a pome, exocarp usually lenticellate, mesocarp hard and dry, endocarp thin. *Seeds* several, testa rather thin, endosperm absent, embryo with flat cotyledons. — **Figs. 14e, 15e, 16.**

Distribution — Less than 15 species, in SE and E Asia, one species also in *W Malesia*.

Note — There is considerable disagreement about the status of this genus: must it be combined with *Pyrus*, with *Sorbus*, with *Aria*, or be kept separate? For the time being I prefer to cling to my earlier (1973) decision to keep the genus separate.

Micromeles corymbifera (Miq.) Kalkman, *Blumea* 21 (1973) 437. — *Vaccinium? corymbiferum* Miq., *Fl. Ind. Bat. Suppl.* 1 (1861) 588. — *Sorbus corymbifera* (Miq.) Hiep & Yakovlev, *Bot. J.* 66 (1981) 1188. — Type: *Junghuhn s.n.* (*Pl. Jungh. Ined.* 1035), Sumatra.

Pyrus granulosa Bertoloni, *Mem. Accad. Sc. Bologna* II, 4 (1864) 312, pl. 3; Ridley, *Fl. Mal. Penins.* 1 (1922) 680; Steenis, *Bull. Jard. Bot. Buitenzorg* III, 13 (1934) 242; *Blumea* 12 (1964) 14 (transfer of *Vaccinium corymbiferum*). — Type: *Hooker f. & Thomson 'Pyrus c'*, India.

Micromeles malayensis Ridley, *J. Bot.* 62 (1924) 296. — Type: *Nur 11241*, Malaya.

Photinia bartlettii Merr., *Pap. Mich. Acad. Sc.* 19 (1934) 155; Steenis, *Bull. Jard. Bot. Buitenzorg* III, 13 (1934) 242. — Type: *Bartlett 8662*, Sumatra.

Trees up to 30 m, or shrubs, sometimes hemi-epiphytic, deciduous, bark brown, scaly. *Twigs* glabrous or with very few hairs, with light-coloured lenticels. *Leaves* oblong to elliptic-oblong, rarely ovate, 7–13 by 4–7.5 cm, base acute, more rarely rounded, margin shallowly serrate with usually the basal quarter entire, apex acute to acuminate, herbaceous, with 8–11 pairs of nerves, venation transverse, not very prominent, sometimes with small, cylindrical glandular outgrowths on midrib above, very young leaves sometimes (see Note) ferruginous-woolly, but also in that case mature leaves entirely glabrous, the indumentum disappearing completely. *Petiole* 1–3 cm long, red as are midrib and leaf margin. *Stipules* early falling, very small and bristle-like, but sometimes on the basal leaves of a shoot well-developed and up to 6 by 1 mm. *Inflorescence* up to 7 cm long, branched

up to the third order with the lower primary branches axillary to normal leaves, all axes, including the up to 5 mm long pedicels, glabrous, sometimes with few hairs, rarely densely hairy (see Note). *Flowers* 5-merous, fragrant. *Hypanthium* obconoid, often more or less abruptly widened in upper part, 2–3 mm high, the upper 1 mm free from the ovary and falling after anthesis, glabrous outside or with some hairs, inside covered by a glabrous disc. *Sepals* triangular, 1.5–2.5 by 1.5–3 mm, glabrous. *Petals* (broadly) elliptic, ovate or obovate, 4.5–6 by 3–4.5 mm, white, glabrous. *Stamens* 19–24, filaments up to 6 mm, anthers 0.7–1 mm long. *Ovary* (2–)3(–4)-celled, styles distinctly connate in lower part, up to 5.5 mm long. *Fruits* globular to ellipsoid, sometimes more ovoid or obovoid, rarely pear-shaped (see Note), with a large circular scar



Fig. 16. *Micromeles corymbifera* (Miq.) Kalkman. Fruiting branch. Mt Sago, Sumatra. Photo W. Meijer.

at apex, usually still present when young flush appears, 9–19 by 8–17 mm, exocarp brownish, always with corky lenticels, mesocarp very hard and woody. *Seeds* 1 or 2 per cell, flat, up to 5 by 3.5 mm, testa firm-membranous, glabrous. — **Figs. 14 e, 15 e, 16.**

Distribution — Continental Asia: India (Assam), China (Yunnan), Thailand, Laos, Cambodia, Vietnam; *Malesia*: Sumatra, Peninsular Malaysia.

Habitat — Primary montane forest, also in mossy forest, and in more open, shrubby vegetation, at (600?–)1100–3000 m altitude.

Ecology — One of the few examples of the hemi-epiphytic life-style. The plant may start as an epiphytic shrub, later sending down roots and acquir-

ing the tree-habit. It does not seem to be a strangler, killing its host, as some *Ficus* do. See Van Steenis, *Flora Malesiana* I, 4 (1948) xxix, and Corner, *Way-side Trees*, ed. 3 (1988) 620, sub *Pyrus corymbifera* (nom. illeg., non Nakai, 1935).

Notes — Some collections have (traces of) a dense woolly indumentum on inflorescences and leaves, but mostly the specimens are (almost) glabrous, the indumentum that may have been present at a young stage having disappeared rapidly and thoroughly.

In only one collection from Sumatra (*van Steenis 10031*) the fruits are pyriform as in var. *turbinata* Cardot which is known from the continent.

PHOTINIA

Photinia Lindley, Trans. Linn. Soc. Lond. 13 (1821) 103; Kalkman, *Blumea* 21 (1973) 418. — Type species: *Photinia serrulata* Lindley.

Stranvaesia Lindley in Edw., Bot. Reg. 23 (1837) t. 1956. — Type species: *Stranvaesia glaucescens* Lindley.

Unarmed trees or shrubs, evergreen or deciduous, Malesian species all evergreen. *Leaves* simple, entire to serrate, the secondary nerves not running to the margin. *Stipules* free. *Inflorescence* a terminal, panicle- or corymb-shaped compound raceme. *Flowers* bisexual, 5-merous. *Hypanthium* obconoid to campanulate, elongate above the ovary. *Sepals* persistent. *Petals* more or less distinctly clawed. *Stamens* 16–25. *Ovary* semi-inferior, usually hairy on the exposed, free top, (1–)2–5-celled, styles as many as cells, connate at base or free, ovules 2 per cell. *Fruit* a pome, covered at apex by the persistent free part of the hypanthium and the sepals, core consisting of the bony endocarp. *Seeds* 1 or 2 per cell, rather small, testa rather hard, endosperm thin or absent. — **Figs. 14 a, b, 15 a, b, 17.**

Distribution — About 50 species in E Asia, 5 species extending into *Malesia*.

Note — Robertson et al., Syst. Bot. 16 (1991) 391, included the N American genus *Aronia* in *Photinia*.

KEY TO THE SPECIES

- 1a. Leaves, when dry, with many black to brown glandular dots scattered on the under-
side **4. *P. prunifolia***
- b. Leaves without dark dots **2**
- 2a. Leaves entire **3**
- b. Leaves crenate to serrate, at least in upper part **4**
- 3a. Ovary 2- (or 3-)celled **2. *P. integrifolia***
- b. Ovary 4- or 5-celled **1. *P. davidiana***
- 4a. Inflorescences glabrous. Ovary 2- or 3-celled **5. *P. serratifolia***
- b. Inflorescences rather densely shortly woolly. Ovary 4- or 5-celled ... **3. *P. nussia***

1. *Photinia davidiana* (Decne.) Cardot, Bull. Mus. Nat. Hist. Nat. Paris 25 (1919) 399. — *Stranvaesia davidiana* Decne, Nouv. Arch. Mus. Paris 10 (1874) 179. — Type: *David s.n.*, Tibet.

Stranvaesia integrifolia Stapf, Hook. Ic. Pl. 23 (1894) t. 2295; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 246. — Type: *Haviland 1071 K*, Mt Kinabalu.

Shrubs or trees, up to 4.5 m. *Twigs* shortly hairy when young. *Leaves* elliptic to elliptic-oblong or slightly ovate or obovate, 4–9 by 2–4 cm, base rounded to acute, margin entire, apex usually acute and mucronate, sometimes shortly acuminate, stiff-coriaceous, with 7–9 pairs of nerves, often not distinctly different from strong intermediate veins, venation widely reticulate, reddish when young, red before falling, shortly hairy on main nerves when young, glabrescent. *Petiole* 0.5–1 cm long. *Stipules* narrowly triangular, up to 3 by 0.5 mm, keeled inside, sparsely hairy, glandular on the keel, caducous. *Racemes* pyramidal, up to 4 cm long, with up to 8 first order laterals of up to 3.5 cm long and usually branched again, lowermost laterals usually in axils of leaves, rachises hairy, pedicels up to 3 mm long, hairy. *Hypanthium* campanulate, up to 2 mm high, only the basal half connate with the ovary, sparsely hairy outside. *Sepals* triangular, 1–1.5 by 1.7–2 mm, usually ciliolate. *Petals* elliptic to broadly orbicular, up to 4.5 by 4 mm, white to pinkish. *Stamens* 17–20, filaments up to 3 mm, anthers up to 1 mm long. *Ovary* semi-inferior, shortly hairy on the dome-shaped free top, 3-?, 4- or 5-celled, styles up to 3.5 mm long, halfway connate, hairy at extreme base. *Fruits* (sub)globular, up to 8 by 8 mm when dry, free part of hypanthium and sepals closely appressed against the top, exocarp sparsely hairy, red, mesocarp thick and fleshy, up to 2 mm thick when dry, endocarp thin, bony. *Seeds* 1–5, ellipsoid to obovoid, c. 4 by 2 mm, with firm, brown testa. — **Figs. 14b, 15b.**

Distribution — China, Taiwan, N Vietnam; *Malesia*: Sumatra (only few seen, from Aceh), Borneo (only seen from Mt Kinabalu, rather many collections).

Habitat — In Malesia in subalpine shrubland, at 2600–3900 m altitude, on the continent lower.

2. *Photinia integrifolia* Lindley, Trans. Linn. Soc. Lond. 13 (1821) 103; Blume, Bijdr. (1826) 1103; Miq., Fl. Ind. Bat. I, 1 (1855) 387; Backer & Bakh. f., Fl. Java 1 (1964) 513. — Type: *Wallich 669*, Nepal.

Photinia notoniana Wight & Arn., Prod. 1 (1834) 302; Koord. & Valetton, Bijdr. Booms. Java 5 (1900) 361; Koord., Exk. Fl. Java 2 (1912) 318; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 242. — Type: *Wight 1014*, lecto chosen by Vidal, from India.

Photinia notoniana Wight & Arn. forma *grandiflora* Koord. & Valetton, Bijdr. Booms. Java 5 (1900) 361 — Type: not indicated, described from Mt Gedeh, Java.

Shrubs or trees up to 15 m. *Twigs* glabrous or somewhat hairy when young. *Leaves* elliptic to oblong, 4–15(–21) by 2.5–8 cm, base cuneate to rounded, entire (rarely faintly toothed), apex obtuse to acute, usually shortly acuminate, coriaceous, with 6–12 pairs of secondary nerves which are usually not well distinguishable from stronger tertiary ones, venation widely reticulate, glabrous or with few hairs when young. *Petiole* 0.5–4 cm long, often red as are midrib and leaf margins. *Stipules* triangular, up to 2 by 1 mm, early caducous. *Inflorescence* up to 7(–12) cm long, branched up to the 4th order, with up to 12 or more spreading branches of the first order, the lower ones often in axils of leaves and up to 8(–10) cm long, all rachises up to the 0–7 mm long pedicels short-hairy or glabrous. *Flowers* fragrant. *Hypanthium* obconoid, 1–2 mm high, usually glabrous outside. *Sepals* triangular, obtuse, (0.5–) 0.8–1(–1.5) by 1–2 mm. *Petals* (sub)orbicular, 2.5–4 by 2–4 mm, white. *Stamens* 17–21, filaments up to 2.5(–4) mm, glabrous, anthers 0.5–0.8 mm long. *Ovary* usually hairy on the exposed top, 2- (rarely 3-) celled, styles up to 3 mm, usually shortly to halfway connate. *Fruits* subglobular, 4–8 by 3.5–6.5 mm, upper part of hypanthium and sepals closely appressed against top, exocarp red, mesocarp fleshy, endocarp hard, bony. *Seeds* usually 2 per cell, ovoid, up to 4 mm long, with hard, brown, glabrous testa, endosperm thin. — **Figs. 14a, 15a, 17.**

Note — The species has in various ways been divided into varieties, see discussion in Kalkman, *Blumea* 21 (1973) 418. The two varieties as accepted here, certainly have no phylogenetic value whatsoever.

a. var. *integrifolia* — Kalkman, *Blumea* 21 (1973) 423.

The synonyms given above under the species pertain to the type variety.

Twigs always glabrous. Rachises of the inflorescence, including the pedicels glabrous.



Fig. 17. *Photinia integrifolia* Lindley. Fruiting shrub. Mt Arjuno, Java. Photo J. Jeswiet.

Distribution – Continental Asia (Tibet, Nepal, Sikkim, Bhutan, NE India, S China, Thailand, Sri Lanka); *Malesia*: Java, Lesser Sunda Islands.

Habitat – In *Malesia* in montane forest and sub-alpine shrubbery, altitude (1400–)2000–3350 m.

b. var. *sublanceolata* Miq., Fl. Ind. Bat. I, 1 (1855) 387; Kalkman, Blumea 21 (1973) 423. — Type: *Horsfield* 432, Java.

Photinia dasythyrsa Miq., Fl. Ind. Bat. I, 1 (1855) 387; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 242. — Type: fragment in U?

Photinia integrifolia Lindley var. *subdenticulata* Miq., Fl. Ind. Bat. I, 1 (1855) 387. — Type: *Horsfield* 1135, Java.

Twigs glabrous to distinctly hairy when young. Rachises of the inflorescence, including the pedicels with a cover of short, appressed hairs which do not entirely disappear with age.

Distribution – Continental Asia (NE India, Burma, S China, Laos, S India, Sri Lanka; *Malesia*: Sumatra, Malaya, Java, Lesser Sunda Islands.

Habitat – In *Malesia* in montane forest and sub-alpine vegetation, altitude 1300–3200 m.

3. *Photinia nussia* (D. Don) Kalkman, Blumea 21 (1973) 429. — *Pyrus nussia* D. Don, Prod. Fl. Nepal. (1825) 237. — *Stranvaesia nussia* (D. Don) Decne., Nouv. Arch. Mus. Paris 10 (1874) 178; Vidal, Adansonia 5 (1965) 231, 577. — Type: *Hamilton* s.n., lecto, Nepal; Wallich 658, para.

Eriobotrya ambigua Merr., Philipp. Bur. Gov. Lab. Pub. 35 (1906) 19; Enum. Philipp. Flow. Pl. 2 (1923) 226. — *Stranvaesia ambigua* Nakai, J. Arnold Arbor. 5 (1924) 72. — Type: *Meyer* FB 2796, Luzon; paratypes: *Whitford* 1155, 1168, 1307, Luzon.

Eriobotrya oblongifolia Merr. & Rolfe, Philipp. J. Sc., Bot. 3 (1908) 102; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 226. — Type: *Mearns & Hutchinson* FB 4680, Mindanao.

Trees up to 10 m. *Twigs* densely shortly woolly when young, glabrescent. *Leaves* oblong to oblong-lanceolate, 5–11 by 2–4 cm, base acute, margin entire in lower half, shallowly crenate to serrate in upper part, apex acute to shortly acuminate, coriaceous, with 8–15 pairs of secondary nerves, often not distinguishable from stronger tertiary nerves, venation widely reticulate, both surfaces shortly woolly when young, hairs soon vanishing and ultimately quite glabrous. *Petiole* 1–2 cm long. *Stipules* narrowly triangular, 1.5–6 by 0.5–0.8 mm, not very early caducous. *Inflorescences* corymb-shaped, 4–6 cm long, with up to 12 primary branches, the lower ones in axils of leaves and branched again, up to 6 cm long, all rachises densely short-woolly, including the up to 7 mm long pedicels. *Hypanthium* obconoid, 1.5–2.5 mm high, densely short-woolly outside. *Sepals* broadly triangular, 1–1.8 by 1.5–2.5 mm. *Petals* elliptic to ovate, 4–5.5 by 3–3.5 mm, white. *Stamens* c. 20, filaments up to 3 mm, glabrous, anthers 0.7–1 mm long. *Ovary* densely hairy on exposed top, 5- (rarely 4-)celled, styles up to 4.5 mm, half-way connate, with hairs at base. *Fruits* globular, up to 6 mm diam., upper rim of hypanthium and sepals closely appressed against its bulging, dome-shaped, now almost glabrous top, the pericarp thin and brittle when dry, practically glabrous, colour unknown. *Seeds* not seen in mature state.

Distribution — Continental Asia (E Himalayas, NE India, N Burma, N Thailand, N Laos, S China, but not recorded from Taiwan); *Malesia*: Philippines.

Habitat — On the continent in evergreen forest types, altitude 500–1800 m, in the Philippines hardly any information available, but up to 2500 m altitude.

Note — The description only pertains to the Philippine material.

4. *Photinia prunifolia* ((Hook. & Arn.) Lindley in Edw., Bot. Reg. 23 (1837) t. 1956. — *Photinia serrulata* β *prunifolia* Hook. & Arn., Botany Beechey's Voy. (1833) 185. — Type: *Beechey's Coll. s.n.*, Macao.

Small trees up to 12 m, bark (dark) brown. *Twigs* glabrous. *Leaves* lanceolate, 9–14 by 2–4.5 cm, base cuneate, margin irregularly and finely glandular-serrate except at very base, apex gradually taper-

ing, with 12–16 pairs of secondary nerves, not always distinguishable from stronger intermediary tertiary nerves, venation reticulate, glabrous on both sides, glossy above, with many scattered brown to black glandular dots on the dull underside. *Petiole* 0.7–1.5 cm long. *Stipules* subulate, 3–6 mm long, very early caducous. *Inflorescences* corymbose in shape, up to 8 cm long, branched up to the 4th order, with up to 8(–12) branches of the first order, the lower of these in the axils of leaves or bracts, up to 6 cm long, all rachises sparsely and shortly appressed-hairy, pedicels up to 5 mm long, with long appressed hairs. *Hypanthium* obconoid, 1–2 mm high, sparsely hairy to glabrous outside. *Sepals* triangular, 1–1.5 by 1.5–2 mm. *Petals* elliptic, 4–4.5 by 2.5–3 mm, white. *Stamens* c. 20, filaments up to 3 mm, glabrous, anthers c. 0.7 mm long. *Ovary* hairy on exposed top, 2-celled, styles up to 3 mm long, half-way connate, hairy at base. *Fruits* obovoid, c. 6 by 4 mm, free part of hypanthium and sepals closely appressed against its top, exocarp glabrous, colour unknown, mesocarp fleshy, endocarp hard and bony. *Seeds* 3 or 4 per fruit, ellipsoid, 4 by 2 mm, testa with a hard inner layer and a mucilaginous outer layer, endosperm thin, cotyledons flat.

Distribution — China, Vietnam; *Malesia*: Sumatra (only seen from Mt Sago), Borneo (only seen from Mt Kinabalu).

Habitat — In *Malesia* in primary and secondary forest, altitude 1100–1700 m.

5. *Photinia serratifolia* (Desf.) Kalkman, Blumea 21 (1973) 424. — *Crataegus serratifolia* Desf., Catal. Hort. Paris, ed. 3 (1829) 288, 408. — Type: probably non-existent, see discussion in Kalkman, l.c.

Photinia serrulata Lindley, Trans. Linn. Soc. Lond. 13 (1821) 103, nom. illeg., superfl.; DC., Prod. 2 (1825) 631; Blume, Bijdr. (1826) 1103; Miq., Fl. Ind. Bat. I, 1 (1855) 388; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 226; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 242. — *Crataegus glabra* auct. non Thunb., Fl. Japon. (1784) 205; i.a. Aiton, Hort. Kew., ed. 2, 3 (1811) 202; Lindley, l.c., in syn.

Small trees up to c. 15 m. *Twigs* glabrous, bud scales up to 13 by 11 mm, dark and hard. *Leaves* oblong to elliptic, 8.5–13.5 by 3.5–5.5 cm, base acute to rounded, margin finely crenate to serrate, entire only at extreme base, apex acute, sometimes acuminate, with up to 14 pairs of secondary nerves, often not distinguishable from stronger tertiary nerves, venation widely reticulate, not prominent,

with few hairs on both surfaces when very young, quite glabrous when mature. *Petiole* 2–3 cm long. *Stipules* awn-shaped, 4.5–5.5 by 1 mm, with excentric midrib, early caducous. *Inflorescence* corymbose to semi-globular in shape, up to c. 8 cm long, with up to 12 first order laterals, these up to 9 cm long and branched again, the lowermost ones in axils of leaves, rachises including the 2.5–4 mm long pedicels glabrous or faintly hairy. *Flowers* 5-merous, rarely 4-merous. *Hypanthium* obconoid, 1.5–2 mm high, upper half free from the ovary, glabrous outside. *Sepals* broadly triangular, 1–1.2 by 1.2–1.8 mm. *Petals* suborbicular to broadly ovate, 3–4.5 by 3–3.5 mm, white. *Stamens* 16–20, filaments up to 3 mm, glabrous, anthers 0.5–0.8 mm long. *Ovary* hairy on the free top, 2-, rarely 3-celled, styles up to 2.5 mm long, free. *Fruits* subglobular to obovoid with flattened apex, up to

c. 5.5 by 6 mm when dry, upper part of hypanthium and sepals closely appressed against top of fruit, exocarp red (to purple?), mesocarp fleshy, endocarp rather hard. *Seeds* 2–4(–6), ellipsoid, c. 3 mm long, with firm, brown testa, endosperm a thin layer, cotyledons rather flat.

Distribution – S India, China, Japan, Taiwan; *Malesia*: Philippines (seen from Luzon and Mindanao) and doubtfully Sumatra. Often cultivated in Europe.

Habitat – In the Philippines in mossy forest at c. 2500 m altitude.

Notes – About the name change, necessitated by Lindley's name being illegitimate, see Kalkman, l.c.

The one specimen from Sumatra (*Jacobs 4363*) is too poor for reliable identification. The description given only pertains to Philippine collections.

PYRACANTHA

Pyracantha Roemer, Fam. Nat. Syn. Monogr. 3 (1847) 104, 219. — Type species: *Pyracantha coccinea* Roemer (*Mespilus pyracantha* L.), according to some authors, but not designated according to Index Nominum Genericorum.

Evergreen shrubs. *Twigs* often thorny. *Carpels* 5, free from each other but connate with the hypanthium, ovaries semi-inferior, styles free, ovules 2. *Fruits* crowned by persistent sepals, containing 5 pyrenes.

Distribution — Some 12 species in Eurasia. In *Malesia* one planted species.

Pyracantha angustifolia (Franch.) Schneider, Ill. Handb. Laubholz. 1 (1906) 761. — *Cotoneaster angustifolius* Franchet, Pl. Delav. (1889) 221. — Types: *Delavay 47, 61, 3730*, China.

Shrubs, c. 3 m high. *Twigs* glabrous, some transformed into thorns. *Leaves* on short shoots, oblong, 1–3.5 by 0.5–1 cm, base acute to rounded, margin entire, apex rounded, often retuse, mucronate, nerves and veins reticulate, hardly visible, coriaceous, when mature glabrous except remnants of indumentum near midrib above. *Flowers* in short racemes at apex of short shoots, pedicels hairy, up to 8 mm long. *Hypanthium* low-campulate, c. 1 mm high, hairy outside, above the ovaries with a free rim lined inside by a disc. *Sepals* triangular, 1 by 2 mm. *Petals* orbicular, 3 by 3

mm, spreading in anthesis, white. *Stamens* c. 20, filaments up to 2 mm, glabrous, anthers 0.5 mm long. *Ovaries* connate with hypanthium over half their length, hairy on top and dorsally, styles 2 mm, glabrous. *Fruits* depressed globular, 3 by 5 mm, exocarp glabrous, orange (to red?), mesocarp thin-fleshy, 5 pyrenes remaining free from each other, their upper parts exposed, endocarps woody. *Seeds* 2 per cell, flat.

Distribution – Originating from Yunnan, China, planted as an ornamental in Europe and N America. Three herbarium specimens seen, collected (in 1953 and 1958) from planted bush(es) along the Baguio–Bontoc Road, Benguet, Mountain Prov., Luzon.

Habitat – Roadside, at an altitude of 1000 (or 2000?) m.

PYRUS

Pyrus L., Sp. Pl. (1753) 479. — Type species: *Pyrus communis* L.

Trees or shrubs, unarmed or with thorns, deciduous. *Leaves* simple. *Flowers* in few-flowered, simple racemes. *Hypanthium* with a free rim above the ovary, the rim persistent or falling with the sepals. *Ovary* inferior, carpels completely adnate with the hypanthium at base connate with each other, 5-celled, styles free. *Fruit* a pome, mesocarp fleshy and with stone cells, endocarp cartilaginous.

Distribution — In Eurasia c. 12 species.

Note — *Pyrus communis* L., the European pear, is not or hardly cultivated in Malesia. The Oriental pear, *P. pyrifolia* (Burm.) Nakai (syn. *P. serotina* Rehder) is cultivated in some places and is a promising product. See L.P.A.Oyen in E.W.M. Verheij & R.E. Coronel (eds.), Edible fruits and nuts, Plant Res. SE Asia (PROSEA Handbook) 2 (1991) 272–276.

RHAPHIOLEPIS

Rhaphiolepis Lindley ex Ker in Edw., Bot. Reg. 6 (1820) t. 468, nom. et orthogr. cons.; Nakai, J. Arnold Arbor. 5 (1924) 61. — Type species: *Rhaphiolepis indica* (L.) Lindley ex Ker.

Unarmed small trees or shrubs, evergreen. *Leaves* simple, margins entire or incised, nerves not terminating in the margin. *Stipules* free. *Inflorescence* a terminal, compound, rarely simple raceme. *Flowers* bisexual, 5-merous. *Hypanthium* obconoid, elongate above the ovary, the free part at inside covered by a disk. *Sepals* and upper part of hypanthium caducous after anthesis. *Petals* clawed. *Stamens* 15–20. *Ovary* inferior, top covered by the glabrous disk, 2-celled, styles 2, free or connate at base, ovules 2 per cell. *Fruit* a pome, globular to (ob)ovoid, with a distinct circular scar at top, mesocarp fleshy, thin, endocarp thin. *Seeds* 1 or 2 per fruit, large, testa thin and firm, endosperm absent, cotyledons thick. — **Figs. 14d, 15d.**

Distribution — Few species in SE and E Asia, two of them often cultivated as ornamentals. In Malesia one wild species and a cultivated one.

KEY TO THE SPECIES

- 1a. Leaves densely woolly when young, glabrate, with finely reticulate darker venation which is distinctly visible underneath. Hypanthium up to 2.5 mm long, less than half of it free from the ovary **2. *R. philippinensis***
- b. Leaves only slightly hairy when young, soon quite glabrous, with a more coarse venation, not darker and not so clearly visible. Hypanthium 3 mm or longer, half of it or even more free from the ovary **1. *R. indica***

1. *Rhaphiolepis indica* (L.) Lindley ex Ker in Edw., Bot. Reg. 6 (1820) t. 468. — *Crataegus indica* L., Sp. Pl. (1753) 477. — Type: LINN sheet 643.11.

Shrubs or small trees. *Leaves* more or less crowded, oblong to obovate-oblong, 3–7 by 1–2.5 cm, base gradually narrowed, margin serrate, apex acute to obtuse and acuminate, with c. 5 pairs of nerves, herbaceous to subcoriaceous, with some hairs when very young, soon glabrous. *Petiole* up to 0.5 cm long. *Stipules* small, caducous. *Racemes* compound, up to 13 cm long, the peduncle very short, rachises practically glabrous, pedicels up to 5 mm long. *Flowers* fragrant. *Hypanthium* 3–3.5 mm high, sparsely hairy outside. *Sepals* pointed-triangular, up to 5 by 1–1.5 mm long. *Petals* up to 6 mm long, usually white, sometimes pinkish. *Ovary* glabrous, styles loosely connate at base. *Fruits* globular, c. 6 mm diam., black when ripe.

Distribution — SE Asia from Thailand to S China, also in Taiwan and Hainan. The species is cultivated as an ornamental in many countries, also in *Malesia*.

Habitat — On the continent in open types of evergreen forest, up to c. 1300 m altitude.

Note — The description given is based on specimens cultivated in Java. The variation in the wild is much larger. See also the note under the following species.

2. *Rhaphiolepis philippinensis* (Vidal) Kalkman, Blumea 21 (1973) 434. — *Eriobotrya philippinensis* Vidal, Rev. Pl. Vasc. Filip. (1886) 123; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 226; Vidal, Adansonia 5 (1965) 577, in obs. — Types: Vidal 1350, 1353, both Luzon.

Photinia luzoniensis Merr., Philipp. Bur. Gov. Lab. Pub. 17 (1904) 18; Philipp. J. Sc., Suppl. 1 (1906) 60; Enum. Philipp. Flow. Pl. 2 (1923) 226; Steenis, Bull. Jard. Bot. Buitenzorg III, 13 (1934) 242. — Types: Merrill 3223, holo; 3714, para; both Luzon.

Eriobotrya acuminatissima Nakai, J. Arnold Arbor. 5 (1924) 71. — Type: Martelino & Edaño BS 35622, Panay.

Shrubs or small trees up to 10(–18) m, bark flaky. *Twigs* densely woolly when young, glabres-

cent. *Leaves* oblong or obovate-oblong to lanceolate, rarely elliptic, 5–17 by 2.5–5 cm, base tapering or more rounded, margin sometimes entire, mostly variously incised, at least in the upper part, apex acute or rounded and acuminate, coriaceous, with 7–12 pairs of nerves, often a smaller nerve of about the same strength between two primary nerves, venation finely reticulate, woolly hairy when young on lower surface and near midrib above, indumentum (almost) disappearing with age. *Petiole* 0.5–2.5 cm long. *Stipules* triangular, 2.5–4 by 0.7–1.5 mm, usually rather long persistent. *Inflorescences* 2–7.5 cm long, with up to 8 branches, the lower ones often in the axils of leaves, up to 6 cm long, all rachises including the 2–10 mm long pedicels densely woolly. *Hypanthium* obconoid, 2–2.5 mm high, upper rim free, densely hairy outside. *Sepals* triangular, 1.5–3.5 by 1.2–2 mm. *Petals* elliptic to suborbicular, up to 6.5 by 4.5 mm, white or whitish. *Stamens* 16–20, filaments up to 3.5 mm, glabrous, anthers 0.5–0.8 mm long. *Ovary* 2-celled, styles free or shortly cohering, up to 4 mm long, sometimes glabrous but usually with some hairs at base. *Fruits* ovoid to subglobular, 6–9 by 4–9 mm when dry, with a more or less flattened top but sepals and hypanthium rim sometimes dropping off late, exocarp hairy to glabrous, dark purple when ripe, the mesocarp thin and fleshy, stony when dry, the endocarp thin. *Seeds* 1 or 2 per fruit, rather large, with thin but firm testa. — **Figs. 14 d, 15 d.**

Distribution — *Malesia*: Philippines (several islands, also on Palawan), Borneo (only seen from Sabah).

Habitat — In forest, found at 300–2600 m altitude.

Ecology — Several specimens seen were collected on ultramafic soil. For some other collections bearing no notes this may also be the case.

Notes — It is certainly not impossible that a future monographer will decide that this species has to be included in *Rhaphiolepis indica*. The differences are vegetative and unimpressive but that holds for all species recognized in the genus up till now.

The leaves of the Philippine specimens are average shorter than those in Sabah, but the overlap is large: Philippines 5–14 by 2.5–5 cm, Borneo 11–17 by 3.5–5 cm.

TRIBUS PRUNEAЕ

Woody plants with simple leaves. Stipules on the twigs. Epicalyx absent. Pistil 1, superior, enclosed in hypanthium. Ovules 2, pendulous. Drupaceous fruits, mesocarp sometimes dry. $x = 8$.

PRUNUS

Prunus L., Sp. Pl. (1753) 473; Kalkman, Blumea 13 (1965) 1–115.

Trees or shrubs, rarely with thorns. *Buds* protected by bud scales or naked. *Leaves* simple, pinnately nerved, margin incised or entire, with glands in the margin and/or on the underside or on the petiole. *Stipules* free or (rarely) connate, on the twigs. *Inflorescence* basically a raceme, rarely branched, in a large part of the genus reduced to a few-flowered umbel or to only one or two flowers. *Flowers* normally 5-merous, usually bisexual. *Sepals and petals* well distinct except in sect. *Mesopygeum* where the perianth segments are (sub)equal or irregularly differentiated without (much) difference in size. *Petals* usually white or pink. *Stamens* many (up to 85). *Pistil* 1, at the bottom of the cup-, bell- or funnel-shaped hypanthium, at its base often with hairs implanted on the hypanthium, also when the ovary itself is glabrous; ovary superior, 1-locular; style terminal, stigma capitate; ovules 2, pendulous, only 1 normally developing. *Fruit* a drupe, mesocarp in wild species not very thick, fleshy to (rather) dry, endocarp bony to woody, thin to thick. *Seed* with thin testa, without endosperm. — **Figs. 18–20.**

Distribution — At least 200 species, cosmopolitan. In *Malesia* c. 35 species and one or two rarely cultivated ones.

Habitat — The majority of the species is formed by medium (up to 15 m high) or large (up to 35 m, rarely higher) trees, in different types of forest: primary lowland forest, montane forest, mossy forest. A good number of species are also found in montane or subalpine shrubland and then they often are (large) shrubs.

About 44% of the species *only* occur from sea-level to c. 1500 m altitude, about 32% *only* above 1000 m. The remaining 24% of the species can be found as well below 1000 m as above 1500 m. Only some four species have regularly been collected from altitudes surpassing 3000 m, going up to c. 3700 m.

Taxonomy — The genus *Prunus* contains a fair number of useful species with edible fruits that have since long been domesticated, cultivated, and changed by man. Taxonomy has in the past often over-classified such groups, giving generic status to each of the cultivated species. This has also happened in *Prunus*, where apricot, cherry, almond, peach have been placed in *Armeniaca*, *Cerasus*, *Amygdalus*, *Persica*, respectively. It is more in agreement with standards set in the classification of 'useless' groups to unite these genera and recognize subgenera for some of them. A useful classification of the genus is:

Subgenus *Prunus*

(among others *P. armeniaca* L., apricot; *P. domestica* L., European plum; *P. salicina* Lindl., Japanese plum)

Subgenus *Amygdalus* (L.) Focke

(among others *P. amygdalus* Batsch, almond; *P. persica* (L.) Batsch, peach and nectarine)

Subgenus *Cerasus* (Miller) Focke

(among others *P. avium* L., sweet cherry; *P. cerasus*, sour cherry)

Subgenus *Padus* (Miller) Focke

(among others *P. padus*; *P. serotina*)

Subgenus *Laurocerasus* (Tourn. ex Duhamel) Rehd.

The order in which the subgenera are placed, is not phylogenetical, *Padus* probably being the most 'primitive' subgenus.

Of the subgenera, only *Laurocerasus* is represented in Malesia by native wild species, *Padus* has one insufficiently known species which may or may not be wild (see *Prunus C*), the other three subgenera are distinctly temperate and not successful in cultivation in the Malesian region. Only *P. persica* has been mentioned at the end of the present treatment.

KEY TO FLOWERING SPECIMENS

Specimens bearing flowers only are often not identifiable except by comparing the vegetative parts with fruiting material.

- 1a. Leaves densely dark-dotted on underside. Stipules intrapetiolarly connate 2
- b. Leaves not densely dark-dotted on underside, sometimes pitted on the underside where hairs have been. Stipules connate or free 3
- 2a. Leaves without basal glands. Petals 6–7.5 mm long **3. *P. mirabilis***
- b. Leaves with 2 basal glands, usually on petiole, rarely in margin. Petals up to 4 mm long **2. *P. javanica***
- 3a. Basal glands on the petiole 4
- b. Basal glands on the leaf surface, sometimes in a contraction of the leaf-base, sometimes absent 5
- 4a. Racemes without leaves on the basal part of the rachis **1. *P. adenopoda***
- b. Racemes with 2 leaves under the flowers **Prunus C**
- 5a. Leaves with 2 or more basal glands and with usually many additional glands in two rows parallel with the midrib. Petals 3–8 times as long as sepals **4. *P. wallichii***
- b. Additional glands, when present, not distinctly in two rows parallel with the midrib. Petals at most twice as long as sepals 6
- 6a. Basal leaf-glands deeply hollowed, distinctly bulging above. 7
- b. Basal leaf-glands flat or only slightly hollowed and hardly bulging above, or in all leaves absent 14
- 7a. Racemes solitary and simple. Basal leaf-glands in blade proper 8
- b. Racemes in bundles (short shoots without or with terminal bud) or truly compound. Basal glands sometimes in contraction of the leaf-base 12
- 8a. Stipules free 9
- b. Stipules with the bases of their midribs intrapetiolarly connate 11

- 9a. Stamens 50 or more 23. *P. polystachya*; 26. *P. rubiginosa*
 b. Stamens not more than c. 50 10
 10a. Ovary densely hairy 20. *P. marsupialis*
 b. Ovary glabrous or with few hairs 12. *P. fragrans*
 11a. Stamens 20–40 9. *P. clementis*
 b. Stamens 50–85 23. *P. polystachya*
 12a. Stamens 50 or more. Inflorescences 3.5–11 cm long
 19. *P. malayana*; 23. *P. polystachya*
 b. Stamens not more than 50 13
 13a. Leaves with 5–9 pairs of nerves. Inflorescences up to 1.5(–4) cm long. Ovary
 densely hairy 5c. *P. arborea* var. *densa*
 b. Leaves with 8–12 pairs of nerves. Inflorescences up to 3.5 cm long. Ovary sparse-
 ly hairy to glabrous 31. *P. turfosa*
 See also *Prunus A* with inflorescences up to 10 cm long
 14a. Racemes in bundles (short shoots with or without terminal bud) or truly com-
 pound. 15
 b. Racemes solitary and simple 19
 15a. Stipules intrapetiolarly connate. Inflorescence a compound raceme, 5–10 cm long,
 with 1–5 laterals. Stamens 50–80. Ovary glabrous or with few hairs
 19. *P. malayana*
 b. Stipules free 16
 16a. Ovary glabrous or with few hairs. Basal leaf-glands absent. Stipules usually with one
 large, hollowed gland outside. Stamens 15–40 6. *P. beccarii*
 b. Ovary densely hairy 17
 17a. Perianth differentiated as triangular sepals and elliptic to obovate petals. Stamens
 35–45 33. *P. versteeghii*
 b. Perianth segments subequal 18
 18a. Stamens 10–20 22. *P. oocarpa*
 b. Stamens 10–50(–60) 5. *P. arborea*
 19a. Ovary densely hairy 20
 b. Ovary glabrous or with few hairs 28
 N.B.: Ovary unknown in *Prunus D*, fruits sparsely hairy.
 20a. Stipules intrapetiolarly connate 9. *P. clementis*
 b. Stipules free 21
 21a. Racemes short (–1 cm), peduncle almost none, pedicels up to 2 mm 22
 b. Racemes and pedicels longer. 24
 22a. Leaves thin-papyraceous 15c. *P. grisea* var. *tomentosa*
 b. Leaves coriaceous, stiff 23
 23a. Leaves usually with 2 basal glands. Stipules with 1–3 flat or pustular glands on the
 outside. Racemes with up to 6 flowers. Flowers small (hypanthium 1.5 mm long,
 perianth segments less than 1 mm long) 14. *P. glabrifolia*
 b. Leaves usually without basal glands. Stipules with glands in margin but not on sur-
 face. Racemes with up to 10 flowers. Flowers slightly larger (hypanthium 2–3 mm,
 perianth segments 1–1.5 mm long) 21. *P. oligantha*

- 24a. Leaves herbaceous or papyraceous. 25
 b. Leaves coriaceous, often hard and thick
 **8. *P. brassii*; 15a. *P. grisea* var. *grisea*; 22. *P. oocarpa*; 24. *P. pulgarensis*;
 25. *P. pullei*; 27. *P. schlechteri*; 30. *P. subglabra*; 32. *P. turneriana***
- 25a. Racemes short, never over 5 cm long. 26
 b. Racemes (at least some) longer than 5 cm
 27. *P. schlechteri*; 29. *P. spicata*; 32. *P. turneriana*; 33. *P. versteeghii*
- 26a. Leaves thin-herbaceous to papyraceous **15c. *P. grisea* var. *tomentosa***
 b. Leaves herbaceous 27
- 27a. Perianth segments subequal, 7–15
 17. *P. lamponga*; *P. odorata* (Insufficiently known species)
 b. Perianth differentiated as sepals and petals **18. *P. laxinervis***
 N.B.: See also the insufficiently known *P. odorata*.
- 28a. Leaves herbaceous to papyraceous. 29
 b. Leaves coriaceous, stiff 34
- 29a. Racemes up to 3 cm long. 30
 b. Racemes longer than 3 cm 32
- 30a. Leaves papyraceous 31
 b. Leaves herbaceous
 15a. *P. grisea* var. *grisea*; 16. *P. kinabaluensis*; 17. *P. lamponga*
- 31a. Perianth segments subequal **15c. *P. grisea* var. *tomentosa***
 b. Perianth differentiated as sepals and petals, but equal in size
 7. *P. brachystachya*
- 32a. Leaves hairy when young, indumentum still present when mature. Stipules often
 connate **13. *P. gazelle-peninsulae***
 b. Leaves glabrous or practically so when mature. 33
- 33a. Stipules often connate. Racemes up to c. 30 cm long **11. *P. dolichobotrys***
 b. Stipules free. Racemes not longer than 10 cm
 15a. *P. grisea* var. *grisea*; 16. *P. kinabaluensis*; 34. *P. wallaceana*
- 34a. Racemes shorter than 3 cm
 15b. *P. grisea* var. *microphylla*; 28. *P. sclerophylla*
 b. Racemes longer than 3 cm
 **10. *P. costata*; 15a, b. *P. grisea* var. *grisea* and var. *microphylla*;
 16. *P. kinabaluensis*; *Prunus B***

Flowers only known as remnants in *Prunus D* from New Guinea.

Not entered in the key the rarely cultivated *P. persica*.

KEY TO FRUITING SPECIMENS

- 1a. Fruits ovoid or ellipsoid, distinctly longer than wide 2
 b. Fruits (sub)globular or transversely ellipsoid to didymous. 11
- 2a. Leaves dark-punctate on underside 3
 b. Leaves not dark-punctate on underside. 4

- 3a. Fruits 21–29 by 13–16 mm. Basal leaf-glands absent 3. *P. mirabilis*
- b. Fruits 15–23 by 7–12 mm. Basal leaf-glands 2, on petiole or in blade-margin 2. *P. javanica*
- 4a. Basal leaf-glands on the petiole 1. *P. adenopoda*
- b. Basal leaf-glands on the undersurface. 5
- 5a. Leaves with 2 or more basal glands and with usually many additional glands in 2 rows parallel with the midrib 4. *P. wallichii*
- b. Additional leaf-glands, if present, not in two rows parallel with the midrib 6
- 6a. Inflorescence a compound raceme 7
- b. Inflorescence a simple, solitary raceme. 8
- 7a. Fruits 8–11 by 6–8 mm 22. *P. oocarpa*
- b. Fruits 18–25 by 16–21 mm 19. *P. malayana*
- 8a. Fruits not longer than 13 mm, not wider than 11 mm 9
- b. Fruits at least 14 mm long, at least 10 mm wide 10
- N.B.: Fruits 13–21 by 10–15 mm, prominently beaked, in insufficiently known taxon, see Note to 15c. *P. grisea* var. *tomentosa*.
- 9a. Leaves with acute base, with 5–8 pairs of nerves. Fruits 10–13 by 8–11 mm 21. *P. oligantha*
- b. Leaves with rounded to cordate base, with 7–11 pairs of nerves. Fruits 8–11 by 6–8 mm 22. *P. oocarpa*
- N.B.: 10–15 pairs of nerves in *Prunus B*, of which the fruits are insufficiently known.
- 10a. Basal leaf-glands deeply hollowed, distinctly bulging above. Fruits 24–30 by 15–17 mm, not with an apical point or beak 12. *P. fragrans*
- b. Basal leaf-glands flat or only slightly hollowed. Fruits 13–24 by 10–20 mm, included an apical point or beak of 1–4 mm . 17. *P. lamponga*; see also *Prunus D*
- 11a. Basal leaf-glands deeply hollowed, distinctly bulging above. 12
- b. Basal leaf-glands flat or only slightly hollowed, or in all leaves absent 22
- 12a. Basal glands in a contraction of the leaf-base 13
- b. Basal glands in the leaf-blade proper 15
- 13a. Fruits 13–21 by 17–27 mm 23. *P. polystachya*
- b. Fruits not longer than 10 mm, not wider than 12 mm 14
- N.B.: Fruits insufficiently known in *Prunus A*.
- 14a. Leaves with 8–12 pairs of nerves. Fruits subglobular, 7–9 by 8–9 mm 31. *P. turfosa*
- b. Leaves with 5–9 pairs of nerves. Fruits transversely ellipsoid, 6–8.5 by 8–11.5 mm 5c. *P. arborea* var. *densa*
- 15a. Fruits not longer than 10 mm, not wider than 12 mm 16
- b. Fruits longer and/or wider 17
- 16a. Most of the racemes in bundles (short shoots with or without terminal bud) 5c. *P. arborea* var. *densa*
- b. Racemes always solitary 20. *P. marsupialis*
- 17a. Racemes simple and solitary 18
- b. Racemes branched or in bundles (short shoots with or without terminal bud). . . 21

- 18a. Stipules intrapetiolarly connate **9. *P. clementis***
 b. Stipules free. 19
- 19a. Fruits subglobular to obscurely transversely ellipsoid, 16–17 by 16–20 mm
26. *P. rubiginosa*
 b. Fruits transversely ellipsoid, distinctly wider than long 20
- 20a. Leaves with 5–8 pairs of nerves. Fruits 6–13 by 7.5–15 mm **20. *P. marsupialis***
 b. Leaves with 9–12(–14) pairs of nerves. Fruits 13–21 by 17–27 mm
23. *P. polystachya*
- 21a. Fruits ellipsoid to subglobular, 18–25 by 16–21 mm **19. *P. malayana***
 b. Fruits transversely ellipsoid, 13–21 by 17–27 mm **23. *P. polystachya***
- 22a. Racemes in bundles (short shoots with or without terminal bud) or branched, sometimes mixed with solitary, simple ones 23
 b. Racemes all solitary and simple. 26
- 23a. Fruits less than 12 mm long, less than 17 mm wide 24
 b. Fruits more than 15 mm long, more than 16 mm wide. 25
- 24a. Leaves with 2 basal glands. Fruits 5–11.5 by 7–17 mm **5. *P. arborea***
 b. Leaves without basal glands. Fruits 5–7 by 6.5–10 mm **6. *P. beccarii***
 N.B.: Basal glands usually absent in 5a. *P. arborea* var. *robusta*, in which fruits are 9–11.5 by 13.5–17 mm.
- 25a. Racemes compound (branched). Fruits subglobular (or ellipsoid), 18–25 by 16–21 mm **19. *P. malayana***
 b. Racemes in bundles (and sometimes partly solitary). Fruits transversely ellipsoid to didymous, 15–19 by 22–28(–30) mm **33. *P. versteeghii***
- 26a. Seeds hairy, sometimes only sparsely so or only near hilum or apex 27
 b. Seeds entirely glabrous 32
- 27a. Ovary and fruit glabrous 28
 b. Ovary densely hairy, fruit still with hairs. 30
- 28a. Leaves stiff-coriaceous. Fruits transversely ellipsoid, 6–10 by 8–11.5 mm
10. *P. costata*
 b. Leaves herbaceous. 29
- 29a. Leaves glabrous. Stipules free. Fruits subglobular, 12–14 by 13–16 mm
16. *P. kinabaluensis*
 b. Leaves more or less densely hairy when young, hairs not quite disappearing when mature. Stipules often intrapetiolarly connate. Fruits transversely ellipsoid, 8–12 by 11–17 mm **13. *P. gazelle-peninsulae***
- 30a. Fruits 17–33 by 18–34 mm, with thick and woody endocarp **32. *P. turneriana***
 b. Fruits (distinctly) smaller, endocarp not thick and woody 31
- 31a. Leaves very hard and stiff, 4–8.5 by 2–3.5 cm, with 6–9 pairs of nerves. Fruits transversely ellipsoid, 6–7.5 by 7–9 mm **8. *P. brassii***
 b. Leaves herbaceous to coriaceous, 6–17(–20) by 2–8(–10) cm, with 6–13 pairs of nerves. Fruits transversely ellipsoid to subglobular, 9–16 by 9–18 mm
27. *P. schlechteri*

See also 5. *P. arborea*, with racemes normally in bundles but sometimes mixed with solitary ones.

32a. Fruits more than 20 mm wide	33
b. Fruits at most 20 mm wide	34
33a. Fruits compressed subglobular, 17–33 by 18–34 mm, with thick and woody endocarp	32. <i>P. turneriana</i>
b. Fruits transversely ellipsoid to didymous, 15–19 by 22–28(–30) mm	33. <i>P. versteeghii</i>
34a. Fruits (sub)globular, not or not much wider than long.	35
b. Fruits transversely ellipsoid to didymous, distinctly wider than long	47
35a. Fruits more than 13 mm long	36
b. Fruits up to 15 mm long	39
36a. Fruits 13–24 by 10–20 mm, including a distinct apical point or beak of 1–4 mm	17. <i>P. lamponga</i>
b. Fruits not distinctly beaked or pointed	37
37a. Fruits with thick, woody endocarp	32. <i>P. turneriana</i>
b. Endocarp not thick	38
38a. Leaves sparsely hairy when young, glabrous when mature	30. <i>P. subglabra</i>
b. Leaves densely hairy when young, lower surface remaining hairy when mature	24. <i>P. pulgarensis</i>
39a. Stipules intrapetiolarly connate	9. <i>P. clementis</i>
b. Stipules free.	40
40a. Racemes usually not longer than 1 cm.	41
b. Racemes normally longer than 1 cm.	42
41a. Leaves papyraceous	15c. <i>P. grisea</i> var. <i>tomentosa</i>
b. Leaves coriaceous	21. <i>P. oligantha</i>
42a. Leaves herbaceous	43
b. Leaves stiff-coriaceous	46
43a. Ovary densely hairy and fruit still with hairs	44
b. Ovary and fruit glabrous	45
44a. Leaves (rather) densely hairy when young and hairs remaining on underside when mature	29. <i>P. spicata</i>
b. Leaves glabrous when mature	18. <i>P. laxinervis</i>
N.B.: See also 15a. <i>P. grisea</i> var. <i>grisea</i> , where specimens from Java and Lesser Sunda Islands rarely have a densely hairy ovary.	
45a. Leaves with usually more than 2, large glands, all or partly above the base in the blade	16. <i>P. kinabaluensis</i>
b. Leaves usually with 2 glands at the base	15a. <i>P. grisea</i> var. <i>grisea</i>
46a. Leaves (almost) glabrous when mature	15. <i>P. grisea</i>
b. Leaves densely hairy when young and usually still hairy on underside when mature	25. <i>P. pullei</i>
47a. Stipules intrapetiolarly connate	48
b. Stipules free.	49
48a. Rachis of inflorescence hairy. Fruits 13–14 by 14–17(–20) mm	9. <i>P. clementis</i>
b. Rachis glabrous or sparsely short-hairy. Fruits 8–11.5 by 11–15 mm	11. <i>P. dolichobotrys</i>

- 49a. Leaves stiff-coriaceous 50
 b. Leaves herbaceous to papyraceous 53
 50a. Leaves (almost) glabrous when mature 51
 b. Leaves (densely) hairy when young, still hairy on underside when mature 52
 51a. Stipules with 1–3 flat or pustular glands on the outside 14. *P. glabrifolia*
 b. Stipules not with glands on the outside 15. *P. grisea*
 52a. Remnant of hypanthium under the fruit often enlarged, 1.5–8 mm diameter. Leaves often with revolute margins, apex obtuse, sometimes retuse 25. *P. pullei*
 b. Hypanthium remnant under the fruit small. Leaves not with revolute margins, apex acute or shortly acuminate 28. *P. sclerophylla*
 53a. Leaves papyraceous. Inflorescences not exceeding 3 cm in length 54
 b. Leaves herbaceous. Inflorescences usually longer 55
 54a. Fruits 8–12.5(–13.5) mm wide. West Malesia . . 15c. *P. grisea* var. *tomentosa*
 b. Fruits 10–19 mm wide. New Guinea, Australia 7. *P. brachystachya*
 55a. Ovary densely hairy and on fruit still hairs left 56
 b. Ovary and fruit glabrous 57
 56a. Leaves (rather) densely hairy when young, hairs on underside remaining when mature. Flowers and fruits sessile 29. *P. spicata*
 b. Leaves (practically) glabrous when mature. Pedicels longer than 1 mm
 15a. *P. grisea* var. *grisea*
 57a. Flowers and fruits sessile 7. *P. brachystachya*
 b. Pedicels at least 1 mm long 58
 58a. Leaf apex rounded to broadly acuminate 11. *P. dolichobotrys*
 b. Leaf apex gradually tapering to acuminate 59
 59a. Leaves with 5–9 pairs of nerves 15a. *P. grisea* var. *grisea*
 b. Leaves with 8–14 pairs of nerves 34. *P. wallaceana*

Fruits not seen or only in a too young stage in the following species, mentioned under Insufficiently known: *Prunus odorata* from Malaya; *Prunus A* from Borneo; *Prunus B* from Sumatra; *Prunus C* from Luzon.

Not entered in the key the rarely cultivated *P. persica*.

Subgenus *Laurocerasus*

Laurocerasus [Tourn., Inst. (1700) 627, t. 245, '*Lauro-cerasus*'] ex Duhamel, Traité Arbres 1 (1755) 345, t. 133. — *Prunus* subg. *Laurocerasus* (Tourn. ex Duhamel) Rehder, Manual Cult. Trees (1927) 478. — Type species: *Prunus laurocerasus* L.
Pygeum Gaertner, Fruct. Sem. Pl. 1 (1788) 218, t. 46; Koehne, Bot. Jahrb. 51 (1913) 177–224; ibid. 52 (1915) 334–345. — Type species: *Pygeum zeylanicum* Gaertn. = *Prunus ceylanica* (Wight) Miq.

Evergreen, rarely deciduous trees and shrubs. *Leaves* with entire or incised margin, basal glands either flat and on the underside of the blade, or flat to cushion-shaped and in the margin, or on the petiole. *Inflorescence* a raceme, usually simple but sometimes branched, the racemes sometimes placed in bundles, in axils of extant or fallen leaves or cata-

phylls. *Hypanthium* circumscissile after anthesis and its basal part persistent under the fruit. *Perianth* regular and biseriate or with (sub)equal segments.

Taxonomy — The inclusion of *Pygeum* in *Prunus* subg. *Laurocerasus* was elaborated and explained in Blumea 13 (1965).

Laurocerasus and *Padus* were united into one subgenus of *Prunus* by Koehne, Bot. Jahrb. 52 (1915) 279–333, but nowadays it is more usual to keep them as separate subgenera (if not as genera, see under the genus description).

The subgenus *Laurocerasus* can be divided into three sections, as explained in 1965:

- section *Laurocerasus*, also in Malesia;
- section *Mesopygeum* containing most but not all of the former genus *Pygeum*, predominantly Malesian;
- a section of South-, Central-, and some North-American species which does not yet have a formal name.

Uses — None of the species is a well-recognized source of useful timber, although of course the wood may be used locally. Medicinal uses of the bark are less often reported than could be expected from the presence of cyanogenetic glycosides. Culinary uses of the leaves are rare. In New Guinea bark of several species is used for the manufacturing of waist-belts, and it seems to be suitable for basket-work too.

Note — The variation in fruit size is in some cases very large, as appears from the descriptions. This recorded variation is partly caused by the fact that measurements were taken from dried specimens, where it is often impossible to distinguish between full-grown fruits and the not yet fully developed ones. Especially in fruits with a fleshy mesocarp this may give significant differences in size. However, this will not be the only explanation and at least in some species (e.g. *P. turneriana*) natural variation seems to be large also within one individual.

Section *Laurocerasus*

Leaves entire or with incised margin, basal glands on undersurface, in margin, or on petiole. *Perianth* regularly biseriate, petals by shape and texture distinct from sepals and (1.2–) 2–8 times as long as the latter. *Fruits* usually longer than wide, sometimes (sub)globular, rarely transversely ellipsoid.

Distribution — About 14 species in tropical Africa and tropical Asia, and in adjoining subtropical to cool-temperate regions: Macaronesia, Portugal, SE Europe, N Iran, China, Japan. In Malesia 4 species, only *Prunus javanica* of wide distribution.

1. *Prunus adenopoda* Koord. & Valeton, Bull. Inst. Bot. Buitenzorg 2 (1899) 10. — *Prunus macrophylla* Sieb. & Zucc. var. *adenopoda* Vidal, Adansonia 4 (1964) 145, comb. illeg. — *Laurocerasus adenopoda* (Koord. & Valeton) Browicz, Arbor. Kórn. 15 (1970) 6. — Types: *Koorders 6419*, holotype; *Koorders 10014*; both Java.

Prunus pseudoadenopoda Koord., Bull. Jard. Bot. Buitenzorg III, 1 (1918) 84, f. 5. — Type: *Koorders 40165*, Java.

Prunus javanica auct. non (Teijsm. & Binn) Miq.: Meeuse & Adelb. in Backer, Bekn. Flora Java, emerg. ed. IV C 2 (1943) fam. 116, 24, p.p.; Backer & Bakh. f., Fl. Java 1 (1964) 521, p.p.

Trees up to 12 m. *Twigs* glabrous. *Leaves* elliptic to oblong, 8–17 by 4–6.5 cm, base acute to ± rounded, margin entire, apex acuminate, coriaceous, with 7–10 pairs of nerves, these hardly prominent below, venation hardly visible, both sides glabrous,

basal glands mostly 2 on the petiole, large and protruding. *Petiole* 7–10(–12) mm long. *Stipules* narrowly triangular, 5–12 by c. 1 mm, free, (almost) glabrous. *Racemes* solitary, in the axils of extant or (rarely) fallen leaves, up to 2.5 cm, peduncle \pm absent, rachis pubescent, some empty bracts at base of raceme, pedicels up to 2.5 mm, longer under fruit. *Hypanthium* 1.5–2 mm high, (almost) glabrous outside. *Sepals* triangular, c. 1 mm long, ciliate at apex. *Petals* orbicular, 2.5–3 mm long. *Stamens* 25–35, filaments up to 5 mm long, anthers up to 0.5 mm long. *Ovary* glabrous, style up to 4.5 mm. *Fruits* ellipsoid, base attenuate, apex acute, 19–22 by 10–13 mm, mesocarp probably thick when fully ripe and living fruits possibly up to c. 24 by 18 mm, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution – Java, from Ujung Kulon in West to Malang Prov. in East), also on Nusakambangan Island.

Habitat – At low altitudes, up to 500 m, in forest but data scarce, also coastal.

Ecology – Some specimens collected on lime-containing soil.

2. *Prunus javanica* (Teijsm. & Binn.) Miq., Fl. Ind. Bat. I, 1 (1855) 365; Koord. & Valetton, Ic. Bogor. 2 (1904) 169, t. 140; Koord., Atlas 1 (1913) pl. 95; Merr., Enum. Born. Flow. Pl. (1921) 289; Backer & Bakh. f., Fl. Java 1 (1964) 521, excl. syn. *P. adenopoda*; Prance & Whitmore in Tree Fl. Malaya 2 (1973) 338; Cockburn, Trees Sabah 2 (1980) 98, f. 26. — *Cerasus javanica* Teijsm. & Binn., Natuurk. Tijdschr. Ned. Indië 2 (1851) 309. — *Laurocerasus javanica* (Teijsm. & Binn.) Browicz, Arbor. Kón. 15 (1970) 6. — Type: *Teijsmann s.n.*, Java.

Prunus junghuhniana Miq., Pl. Jungh. (1855) 402; Miq., Fl. Ind. Bat. I, 1 (1855) 366; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 234. — Type: *Junghuhn s.n.*, Java.

Prunus martabanica Kurz, For. Fl. Brit. Burma 1 (1877) 434; Ridley, Fl. Mal. Penins. 1 (1922) 672. — Type: *Wallich 4902*.

Platea oblonga Korth. ex Valetton, Crit. Overz. Olacin. (1886) 252. — Type: *Korthals s.n.*, Borneo. See Sleumer, Blumea 17 (1969) 248.

Prunus scortechinii (King) Koehne, Bot. Jahrb. 52 (1915) 297. — *Prunus martabanica* Kurz var. *scortechinii* King, J. As. Soc. Bengal 66, 2 (1897) 286. — Types: *King's Coll. 5638*, *Scortechinii 1782*, Malaya.

Prunus forbesii Koehne, Bot. Jahrb. 52 (1915) 297. — Type: *Forbes 2728*, Sumatra.

Prunus papuana Koehne, Bot. Jahrb. 52 (1915) 299.

— Types: *Schultze 22, 49*, New Guinea, probably lost.

Trees up to 35 m, rarely buttressed, bark smooth, peeling, red- to darkbrown, with distinct smell. *Twigs* glabrous, small cataphylls at base of shoots. *Leaves* ovate to oblong-ovate, rarely lanceolate, 8–20 by 3–7.5 cm, base rounded to acute, margin entire, apex tapering to long-acuminate, surface densely black-punctate beneath, herbaceous to slightly coriaceous, with 8–12 pairs of nerves, venation not very distinct, both sides glabrous, basal glands small, usually 2 on the petiole just below the blade, sometimes in the margin of the blade. *Petiole* 0.5–1(–1.5) cm. *Stipules* narrowly triangular to lanceolate, up to 5 by 1.5 mm, connate with their excentric keeled midribs. *Racemes* solitary, in axils of usually fallen leaves, 2–5 cm, in fruit longer, peduncle very short, rachis glabrous or pubescent, some empty bracts at base of raceme, pedicels up to 5(–7) mm. *Flowers* 5(–6)-merous. *Hypanthium* c. 2 mm high, glabrous outside or with few hairs. *Sepals* triangular, 0.5–1 mm long, hairy at apex. *Petals* elliptic to orbicular, 2.5–4 mm long, white. *Stamens* 25–50, filaments up to 6 mm, anthers up to 1 mm long. *Ovary* glabrous, style up to 4.5 mm. *Fruits* ovoid to ellipsoid, base rounded, apex acute, 15–23 by 7–12 mm, red when ripe, the endocarp glabrous inside. *Seed* with glabrous testa.

Distribution – Burma, Thailand, Vietnam, S Andaman I.; *Malesia*: Sumatra, Peninsular Malaysia, Borneo, Java (not seen from East), Palawan, Celebes, Bali (dubious, only one specimen with obscure label), Moluccas, New Guinea (only seen from Irian Jaya, up to the border with Papua New Guinea).

Habitat – In primary and secondary forest, altitude 0–1500 m.

Uses – Rarely noted. Bark used for rice-bins (Sabah, *Tikau SAN 26474*), as vermicide for buffalo (Sabah, *Kandilis SAN 10323*) and as fish poison (Kalimantan, *Nooteboom 4449*).

Note – The length/width index of the leaves varies from 2 to 4, but narrow-leaved specimens (especially collected in Borneo, but by no means restricted to the island) are not separated by a discontinuity from the others.

3. *Prunus mirabilis* Kalkman, Blumea 13 (1965) 49. — *Laurocerasus mirabilis* (Kalkman) Browicz, Arbor. Kón. 15 (1970) 6. — Type: *Chew, Corner & Stainton 1097*, Mt Kinabalu, Sabah.

Trees up to 12 m. *Twigs* glabrous, with 2 cataphylls at base of shoots. *Leaves* elliptic to elliptic-oblong, 10–15 by 4–6 cm, base rounded, margin entire, apex acuminate, dark-punctate below, coriaceous; with 9–12 pairs of nerves, often on lower surface a rather strong parallel vein between two nerves, both sides glabrous, basal glands absent. *Petiole* 1–1.2 cm long. *Stipules* oblong-ovate, c. 4 by 1.5–2 mm, connate by their excentric keels, almost glabrous. *Racemes* solitary, in axils of fallen leaves, in fruit up to 14 cm long, peduncle 0.5 cm, rachis sparsely pubescent, pedicels 4–6 mm, growing after anthesis. *Flowers* 5–6-merous. *Hypanthium* c. 4 mm high, glabrous outside. *Sepals* rounded-triangular, 2–3 by 1.7–2 mm, ciliate. *Petals* ± orbicular, 6–7.5 by 5–7.5 mm, (almost) glabrous. *Stamens* c. 40, filaments 6–10 mm, anthers 1 mm long. *Ovary* glabrous. *Fruits* ellipsoid, base rounded to tapering, apex acute, 21–29 by 13–16 mm, glabrous, probably red when ripe, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — Only known from few specimens collected in different places on Mt Kinabalu, Sabah.

Habitat — Few notes, at altitudes 1950–c. 3200 m, probably in forest.

Note — Resembling the wider-leaved forms of *P. javanica*, but by its large flowers conspicuously different.

4. ***Prunus wallichii*** Steudel, Nomencl., 2nd ed., 2 (1841) 404; Merr., Contr. Arnold Arbor. 8 (1934) 72; Merr., Brittonia 4 (1941) 88; Prance & Whitmore in Tree Fl. Malaya 2 (1973) 337. — *Prunus acuminata* (Wall.) Dietr., Syn. 3 (1843) 42, comb. illeg. non Michx. (1803): Koehne, Bot. Jahrb. 52 (1915) 296, incl. varieties. — *Cerasus acuminata* Wall., Pl. As. Rar.

2 (1831) 78. — *Laurocerasus wallichii* (Steudel) Browicz, Arbor. Kórn. 15 (1970) 5. — Type: *Wallich* 719.

Shrubs or trees rarely larger than 12 m, bark smooth or warty, brown. *Twigs* glabrous, some small cataphylls at base of shoots. *Leaves* elliptic to oblong or ovate, 7–15 by 2–6 cm, base mostly acute, margin entire, sometimes in upper half serr(ul)ate, apex acuminate, often thin-herbaceous, with 6–9 pairs of nerves, often distinctly looped and joined, venation hardly visible, both sides glabrous, basal glands 2 or more, on the blade-surface, additional glands usually many, in two rows ± parallel with the midrib. *Petiole* 0.2–1 cm long. *Stipules* narrowly triangular, 4–6 by 0.7–1 mm, free, glabrous. *Racemes* solitary or in fascicles of 2–4, axillary, 2–10 cm, peduncle short, rachis ± glabrous, pedicels 2–8 mm, ± glabrous. *Hypanthium* 1.5–2 mm high, glabrous outside. *Sepals* triangular, 0.5–0.8 mm long, glabrous outside. *Petals* elliptic, 2–4 mm long, white. *Stamens* 10–20(–30), filaments up to 3 mm, anthers 0.6–0.8 mm long. *Ovary* densely to sparsely hairy but usually glabrous on the suture, sometimes reduced, style up to 4 mm. *Fruits* ovoid to ellipsoid, base rounded, apex ± acute, 10–18 (–20) by 6–11 mm when dry, probably up to 22 by 15 mm in living state, glabrous, purplish black, mesocarp thick and fleshy when ripe, endocarp thin, glabrous inside. *Seed* with glabrous testa.

Distribution — Continental Asia (NE India, Pakistan, China, Burma, Thailand, Laos, Vietnam); *Malesia*: Sumatra (West and North Prov.), Peninsular Malaysia (only seen from Pahang).

Habitat — Montane and subalpine forest and thickets, at altitudes (600–)1000–3000(–3600) m.

Uses — Seeds edible (W. Meijer, in litt., 1965).

Section Mesopygeum

Leaves always with entire margin, basal glands, if present, on the undersurface. *Perianth* with 5–14 segments which are subequal or more or less distinctly differentiated as sepals and petals, but the latter at most 1.5(–2) times as long as the former. *Fruits* usually transversely ellipsoid or didymous, sometimes (sub)globular, in few species ellipsoid.

Distribution — 33 species in tropical Asia, from India to Solomon Islands, 2 species also in Australia. In *Malesia* 30 species.

5. ***Prunus arborea*** (Blume) Kalkman, Blumea 13 (1965) 90; Prance & Whitmore in Tree Fl. Malaya 2 (1973) 338; Cockburn, Trees Sabah 2 (1980) 96, f. 26; Corner, Wayside Trees Malaya,

ed. 3, 2 (1988) 619. — *Polydonta arborea* Blume, Bijdr. (1826) 1105. — *Pygeum arboreum* (Blume) Blume, Mém. Bot. nr. 2 (1855) 11; C. Muell. in Walp., Ann. 4 (1857) 642; Backer & Bakh. f.,

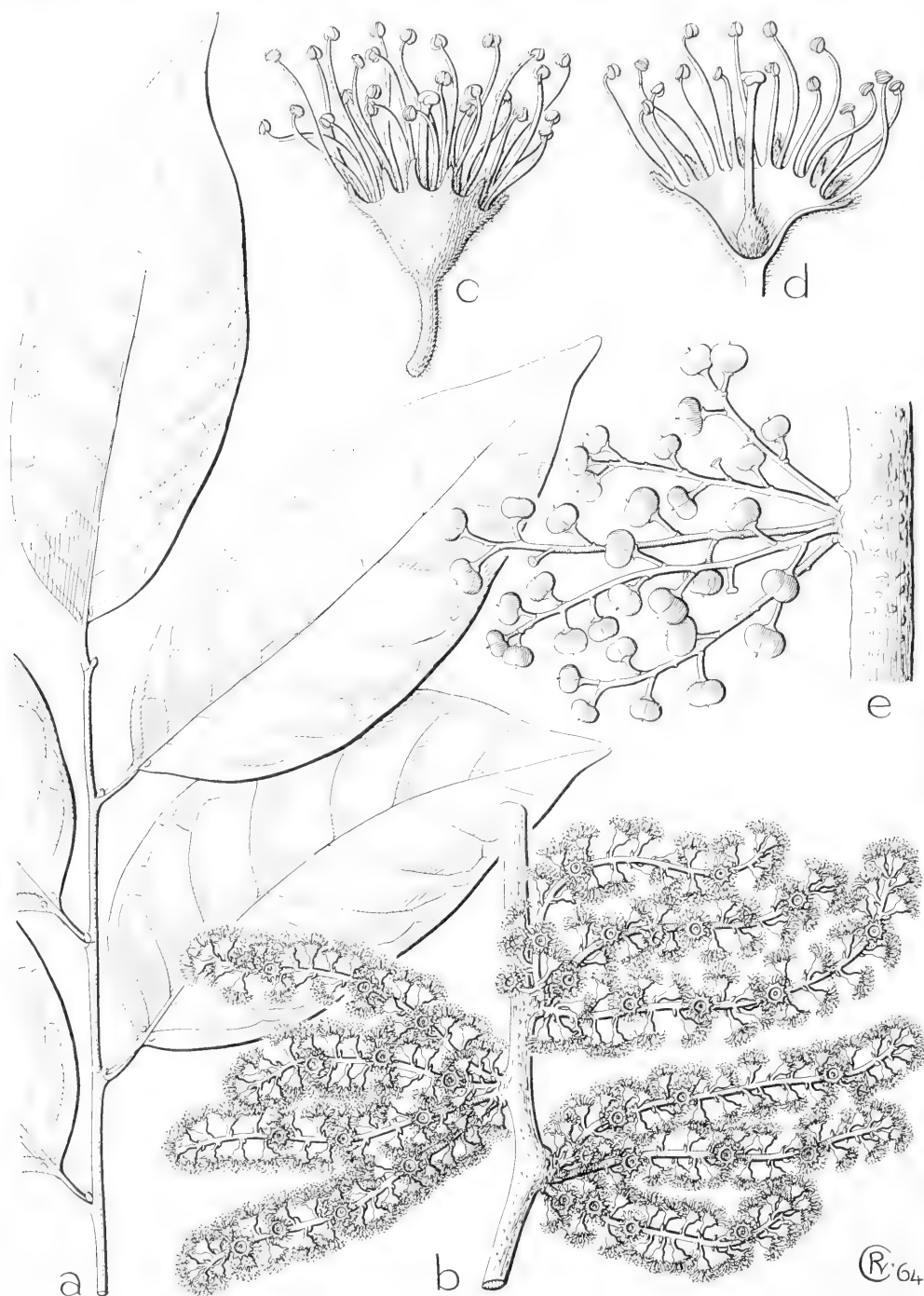


Fig. 18. *Prunus arborea* (Blume) Kalkman. a. Leafy twig, $\times 0.7$; b. bundles of flowering racemes, $\times 0.7$; c, d. flower, from outside and halved lengthwise, $\times 4$; e. fruiting racemes, $\times 0.7$ (a: *De Monchy 1*; b–d: *Koorders 6389*; e: *Goodenough & Ridley 1561*).

Fl. Java 1 (1964) 520, p.p., syn. *Pygeum latifolium* excluded. — *Pygeum blumei* Teijsm. & Binn., Cat. Hort. Bog. (1866) 252, nom. superfl. — Type: *Blume 654*, Java. Blume, Mél. Bot. was effectively published in 1855, see Van Steenis, Taxon 35 (1986) 272–285. *Pygeum arboreum*, therefore, does not have (Blume) Endl. ex C. Muell. in Walp. as author, but (Blume) Blume. Endlicher, Gen. Pl. (1840) already reduced *Polydonta* to *Pygeum*, but did not make the specific combination.

Pygeum parviflorum Teijsm. & Binn., Nat. Tijds. Ned. Indië 2 (1851) 309; Miq., Fl. Ind. Bat. I, 1 (1855) 361; Koord. & Valeton, Bijdr. Booms. Java 5 (1900) 350, incl. vars.; Koord., Atlas 1 (1913) pl. 112, 113; Ridley, Fl. Mal. Penins. 1 (1922) 675. — Type: *Teijsmann & Binnendijk s.n.*, cult. Java, L sheet 908.196–192.

Digaster sumatranus Miq., Sum. (1861) 129, 330. — *Pygeum sumatranum* (Miq.) Miq., Sum. (1861) 619. — Types: *Teijsmann HB 3968*, lecto; *Jung-huhn s.n.*, L sheet 908.191–907; both Sumatra. For more complete synonymy, see Kalkman, l.c.

Trees up to 35 m, sometimes buttressed, bark usually smooth, brown or grey, strongly smelling, sometimes (var. *densa*, *stipulacea*, *alticola*) shrubs. Twigs more or less densely hairy, more or less glabrate with age. Leaves elliptic to oblong or ovate to lanceolate, 3–25 by 1.5–13 cm, base acute to subcordate, apex acute to acuminate, herbaceous to coriaceous, with 5–16 pairs of nerves, sparsely to densely pubescent when young, indumentum rapidly disappearing or persistent, basal glands usually 2, flat or slightly to distinctly hollowed, Petiole (0.2–)0.5–1.5(–2) cm. Stipules variable in shape and size, free, sometimes with conspicuous glands outside, sometimes rather persistent. Racemes in axils of extant or fallen leaves, usually fascicled but sometimes solitary, sometimes truly compound, 0.5–6(–9) cm long, peduncle short, rachis (densely) pubescent, pedicels 0–6 mm long, pubescent. Flowers fragrant. Hypanthium 1–3 mm high, pubescent outside. Perianth segments 5–11, usually subequal, sometimes recognizable as sepals and petals, 0.5–1 mm long. Stamens 10–50(–60), filaments up to 7 mm, often hairy at base, anthers 0.2–1 mm long. Ovary densely hairy, style up to 5.5 mm, hairy at base. Fruits globular (not in Malesia) or subglobular to transversely ellipsoid or didymous, 5–11.5 by 7–17 mm, more or less hairy, from green turning white, red, and ultimately purple or black, the endocarp glabrous or hairy inside. Seed with hairy or glabrous testa. — Fig. 18.

Distribution — Continental Asia, throughout Malesia.

Uses — Timber useful in house building. Bark once reported to be suitable for making rice containers (var. *robusta*, Flores, Schmutz 2803).

Note — This variable species was previously (Kalkman, l.c.) divided into five varieties of which one, var. *montana* (Hook. f.) Kalkman, does not occur in Malesia. A sixth variety, var. *alticola*, can now be added. The varieties are connected by odd intermediary specimens.

KEY TO THE VARIETIES

- 1a. Seeds hairy 2
 - b. Seeds glabrous 5
 - 2a. Twigs and leaves pubescent when young but soon glabrous 3
 - b. Twigs and leaves long retaining their dense indumentum 4
 - 3a. Fruits 5–10.5 by 7.5–13.5 mm. Flowers small: hypanthium 1–2 mm high
 - b. var. **arborea**
 - b. Fruits 9–11.5 by 13.5–17 mm. Flowers larger: hypanthium 2–3 mm high d. var. **robusta**
 - 4a. Leaves elliptic to oblong, rarely ovate, 10–22(–25) by 4–9(–13) cm, with usually 10–13 pairs of nerves . . . e. var. **stipulacea**
 - b. Leaves ovate to elliptic, 6–13(–16) by 2.5–8.5(–12) cm, with 8–10 pairs of nerves
 - a. var. **alticola**
 - 5a. Nerves 5–9 pairs. Racemes 0.5–1.5 cm long
 - c. var. **densa**
 - b. Nerves 8–13 pairs. Racemes longer than 2 cm 4
- a. var. **alticola** Kalkman, Blumea 37 (1993) 378.
— Type: *De Wilde c.s. 15994*, Sumatra.

Twigs densely hairy when young, tardily glabrescent. Leaves ovate to elliptic, 6–13(–16) by 2.5–8.5(–12) cm, hard and stiff, densely hairy when young and also mature leaves usually still distinctly hairy on midrib above, on midrib and nerves below, and on petiole, nerves 8–10 pairs, basal glands 0–2, flat or slightly hollowed. Stipules elliptic to (broadly) ovate, 3–7 by 2.5–7 mm, sometimes with one or more glands outside. Racemes solitary or in bundles of 2–4, (1–)2–4(–6) cm long. Fruits transversely ellipsoid, rarely subglobular, 6–10.5 by 7–14(–16) mm, usually still (sparsely) hairy. Seed glabrous or with few hairs on testa.

Distribution — Sumatra, Borneo (seen from Sabah and Sarawak only), Celebes (one specimen only).

Habitat — Montane forest, also mossy forest, montane scrub, altitude c. (1000–)1500–3000 m.

Note — See note under var. *stipulacea*. For a comparison with *Prunus oocarpa* see under that species.

b. var. arborea — Kalkman, Blumea 13 (1965) 93. The synonyms given above under the species pertain to the type variety.

Twigs pubescent when young, soon glabrous. *Leaves* oblong to ovate, sometimes more lanceolate, 6–21 by 2.5–8.5(–10) cm, pubescent when young but early glabrescent, nerves 7–12 pairs, basal glands usually 2, flat. *Stipules* elliptic to ovate, 1.5–6(–8) by 1–4 mm. *Racemes* in bundles of usually 2–5, (1–)2–6(–9) cm long. *Fruits* transversely ellipsoid to didymous, 5–10.5 by 7.5–13.5 mm. *Seed* with densely hairy testa, rarely more sparsely hairy.

Distribution — Throughout *Malesia*.

Habitat — Primary (and secondary) forest, altitude 0–1800 m.

c. var. densa (King) Kalkman, Blumea 13 (1965) 100.

Pygeum parviflorum Teijsm. & Binn. var. *densum* King, J. As. Soc. Beng. 66, 2 (1897) 292. — Type: *King's Coll.* 10753, holotype; *King's Coll.* 6986; both Malaya.

Twigs densely pubescent, glabrescent. *Leaves* ovate or elliptic to elliptic-oblong, 3–15 by 1.5–8(–9) cm, densely pubescent when young, usually still hairy beneath when mature, nerves 5–9 pairs, basal glands usually 2, flat or distinctly hollowed and sometimes situated in the contracted leaf-base. *Stipules* ovate to elliptic, 1.5–6 by 1–4 mm, sometimes with one or more crater-like glands outside. *Racemes* in bundles of 2–4, mixed with solitary ones, rarely compound, 0.5–1.5(–4) cm long. *Fruits* transversely ellipsoid, 6–8.5 by 8–11.5 mm. *Seed* with glabrous testa.

Distribution — Peninsular Thailand; *Malesia*: Sumatra, Malaya incl. Penang and Tioman Is., Borneo.

Habitat — Lowland and montane forest, altitude (50–)500–2400 m.

d. var. robusta (Koord. & Valeton) Kalkman, Blumea 13 (1965) 96.

Pygeum robustum (Koord. & Valeton) Koehne, Bot. Jahrb. 51 (1913) 198. — *Pygeum parviflorum* Teijsm. & Binn. var. *robustum* Koord. & Valeton, Bijdr. Booms. Java 5 (1900) 353. — Types: *Koorders* 23039, lectotype; 6466, 21598, all Java.

Twigs pubescent when young, soon glabrous. *Leaves* ovate or ovate-lanceolate, 10–19 by 4–7(–10) cm, pubescent when young, early glabrescent, nerves 6–10 pairs, basal glands usually absent. *Stipules* ovate to elliptic, 3.5–6 by 1.5–3(–6) mm, often with inconspicuous flat glands outside. *Racemes* usually in bundles, sometimes compound (branched from the base), mixed with solitary ones, 3–6 cm long. *Fruits* transversely ellipsoid to didymous, 9–11.5 by 13.5–17 mm. *Seed* with hairy testa.

Distribution — East Java, Bali, Flores.

Habitat — Forest in periodically (very) dry regions, 800–1800 m altitude.

e. var. stipulacea (King) Kalkman, Blumea 13 (1965) 98, p. p.

Pygeum stipulaceum King, J. As. Soc. Beng. 66, 2 (1897) 287; Ridley, Fl. Mal. Penins. 1 (1922) 673. — Type: *King's Coll.* 11020, Malaya.

Twigs densely hairy when young, tardily glabrescent. *Leaves* elliptic to oblong, sometimes ovate, 10–22(–25) by 4–9(–13) cm, densely hairy when young, glabrescent but when mature usually still distinctly hairy at least on midrib, nerves and petiole, nerves (7–)10–13(–16) pairs, basal glands 0–2, flat or slightly hollowed. *Stipules* (broadly) ovate, 4–9(–11) by 2.5–6 mm, sometimes with 1–3 glands outside. *Racemes* in bundles of 2–6, not rarely also solitary ones, 2–5(–7) cm long. *Fruits* transversely ellipsoid, 6–8(–11) by 8–13 mm, still hairy. *Seed* with hairy testa, sometimes sparsely so, rarely glabrous.

Distribution — Sumatra, Bangka, Malaya, Singapore, Borneo.

Habitat — Primary and secondary forest, also in kerangas and mossy forest types, altitude 0–1500(–2000) m.

Note — In my 1965 revision (p. 98) a possible subdivision of var. *stipulacea* was alluded to, but not executed. New collections make it possible to extract the higher altitude specimens as a new variety, *alticola*.

6. *Prunus beccarii* (Ridley) Kalkman, Blumea 13 (1965) 104. — *Pygeum beccarii* Ridley, Kew Bull. (1938) 281. — Types: *Haviland b.r.o.b.*, holotype; *Haviland* 755, *Beccari* 3516; all Borneo.

Trees up to 27 m, or shrubs, bark smooth, brown(ish). *Twigs* sparsely hairy when young. *Leaves* elliptic to elliptic-ovate, (6.5–)8–15(–18) by (3–)4.5–8(–9) cm, base rounded or acute, apex rounded or obtuse or shortly acuminate, coria-

ceous, with 4–7(–11) pairs of nerves, venation inconspicuous to invisible, lower side and midrib on upper side sparsely pubescent when young, indumentum rapidly disappearing, basal glands absent, often some flat foliar glands along the margin. *Petiole* 1–2 cm long. *Stipules* ovate to ovate-elliptic, 5–7 by 2–5 mm, free, usually with one large, hollowed gland outside, ciliate. *Racemes* mostly in axils of fallen leaves, in fascicles of 3 or 4, or compound with up to 3 laterals, up to 5.5 cm long, peduncle short, rachis pubescent, pedicels up to 2 mm long. *Hypanthium* 1.5–2 mm high, hairy outside. *Perianth segments* subequal, 6–10, 0.5–1 mm long, often distant, usually densely hairy. *Stamens* 15–40, filaments up to 3.5 mm, anthers 0.3–0.5 mm long. *Ovary* with few hairs or glabrous, style up to 4.5 mm long. *Fruits* transversely ellipsoid, 5–7 by 6.5–10 mm, exocarp sparsely hairy or glabrous, black when ripe, mesocarp thin, endocarp glabrous or with hairs inside. *Seed* with glabrous or hairy testa.

Distribution — Sumatra, Borneo.

Habitat — In forest, altitude 0–900 m.

Note — Only few collections seen from Borneo, and only two sterile collections from Sumatra. The relatively large, hollowed glands in the stipules are characteristic. The seeds are glabrous in five of the fruiting specimens seen (most of them immature), hairy in only one specimen. Judged from the fruits, the ovary may sometimes be more densely short-hairy than seen in the flowering specimens.

7. *Prunus brachystachya* Kalkman, Blumea 13 (1965) 63. — Type: *Henty NGF 10526*, Papua New Guinea.

Usually small trees up to 15(–26) m, sometimes with low buttresses, bark grey to brown. *Twigs* soon glabrous. *Leaves* oblong to ovate, 7–17 by 2–8.5 cm, base rounded to more acute, apex acuminate, herbaceous to papyraceous, with 7–11 pairs of nerves, venation inconspicuous, both sides glabrous (maybe some hairs when young), basal glands 2, flat. *Petiole* up to 1 cm long. *Stipules* narrowly triangular to linear, 4–5.5 by 0.5–1.5 mm, free, hairy outside. *Racemes* solitary, in axils of extant or fallen leaves, (0.5–)1.5–3 cm long, peduncle very short, rachis (sparsely) hairy, pedicels 0–1 mm long. *Flowers* often (?) unisexual, 4- or 5-merous. *Hypanthium* 1.5–2.5 mm high, hairy outside, once noted as orange by the collector. *Perianth segments* differentiated as sepals and petals, but the two almost equal in size. *Sepals* triangular to elliptic, c. 1 mm long, densely hairy outside. *Petals* elliptic, c. 1 mm long, greenish or

white, hairy. *Stamens* 15–25, glabrous, filaments up to 3.5 mm, anthers 0.3–0.5 mm long. *Ovary* and pistillodium glabrous. *Fruits* transversely ellipsoid to didymous, 9–13 by 10–19 mm, exocarp glabrous, red to black when ripe, mesocarp juicy, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — Papua New Guinea, Irian Jaya (one collection just on the border with PNG), Australia (Queensland).

Habitat — Rain forest, also on riverbanks, altitude up to 450 m.

Notes — The length/width index of the leaves varies from 2 to 4, but the transition from wide to narrow leaves is continuous.

Of the four flowering specimens seen, three had male flowers, the fourth had the stamens and the ovary both well-developed.

8. *Prunus brassii* Kalkman, Blumea 13 (1965) 82. — Type: *Brass 22814*, Papua New Guinea.

Trees up to 25 m, or shrubs, bark pale brown. *Twigs* densely hairy when young, glabrescent. *Leaves* elliptic to elliptic-oblong, 4–8.5 by 2–3.5 cm, base acute to obtuse, apex obtuse and often retuse, very hard and stiff, with 6–9 pairs of nerves, nerves and venation impressed above, venation inconspicuous underneath, both surfaces (rather) densely short hairy when young, glabrescent, basal glands usually 2, flat. *Petiole* 0.5–1.2 cm long. *Stipules* narrowly triangular, 2.5–5 by 1–2 mm, free, hairy outside. *Racemes* solitary, in axils of extant or fallen leaves, 1.5–4.5 cm long, peduncle 0–0.5 cm, rachis densely hairy, pedicels 1–4 mm long. *Hypanthium* 2–3 mm high, densely hairy outside. *Perianth segments* 10–12, more or less differentiated as sepals and petals, but the two whorls not entirely regular, 1–1.5 mm long, sepals slightly shorter than petals and with broader base, densely hairy outside. *Stamens* 20–30, filaments up to 3.5 mm long, glabrous or hairy at base, anthers 0.5–0.8 mm long. *Ovary* densely hairy, style up to 2.5 mm long. *Fruits* transversely ellipsoid, 6–7.5 by 7–9 mm, exocarp hairy, colour unknown, endocarp sparsely hairy inside. *Seed* with hairy testa.

Distribution — Papua New Guinea, seen from Central and Milne Bay Provinces, and with doubt from S Highlands Province.

Habitat — Montane forest types, also mossy forest, and in shrubland, 1900–2250(–2750?) m altitude.

Note — Differs from *Prunus pullei*, to which it seems related, in its hairy seeds.

9. *Prunus clementis* (Merr.) Kalkman, Blumea 13 (1965) 70. — *Pygeum clementis* Merr., Philipp. J. Sc., Bot. (1908) 227; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 232. — Types: *Clemens* 760, lecto; 966; both Mindanao.

Pygeum apoense Elmer, Leaflet Philipp. Bot. 5 (May 1913) 1623. — *Pygeum apoanum* Elmer [in herb.] ex Koehne, Bot. Jahrb. 51 (Dec. 1913) 205, nom. illeg. — Type: *Elmer* 11729, Mindanao.

Trees up to 30 m, bark grey, rough (only one note). *Twigs* hairy, glabrescent. *Leaves* oblong, 10–22 by 3.5–9 cm, base rounded, apex gradually tapering to acuminate, herbaceous, with 9–15 pairs of nerves, venation usually not conspicuous, both surfaces hairy when young, (almost) glabrous when mature, basal glands 2–4, distinctly hollowed to flat. *Petiole* 0.5–0.8 cm long. *Stipules* ovate to narrowly triangular, 5–7.5 by 2–4.5 mm, intrapetiolarly connate by their keeled midribs, with inconspicuous marginal glands. *Racemes* solitary, axillary, 3–7 cm long, peduncle short, rachis hairy, pedicels 1–4 mm long, up to 6 mm under the fruit. *Hypanthium* 2–3 mm high, hairy outside. *Perianth segments* 7–10, equal or subequal, c. 1 mm long, hairy. *Stamens* 20–40, filaments up to 4.5 mm, hairy at base, anthers 0.3–0.4 mm long. *Ovary* densely to more sparsely hairy, style up to 4.5 mm long. *Fruits* compressed subglobular to transversely ellipsoid, 13–14 by 14–17(–20) mm, exocarp more or less hairy to glabrous, dark red (information scarce), endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — Mindanao, Celebes (N peninsula and central part).

Habitat — Primary and secondary forest, altitude 200–1050 m. Some of the fieldnotes on specimens from Celebes indicate a preference for volcanic sand and ultrabasic soil.

Uses — Used as medicine for headache and skin eruptions (*Frake* PNH 36173, probably referring to the bark).

Note — Only two from the c. 10 collections seen were collected in more or less recent times, i.e. after World War II. The Philippine species *Prunus clementis*, *fragrans*, and *rubiginosa* are poorly known.

10. *Prunus costata* (Hemsley) Kalkman, Blumea 13 (1965) 78. — *Pygeum costatum* Hemsley, Kew Bull. 1898 (1901) 98. — Type: *Giulianetti* (via McGregor) s.n., Mt Scratchley.

Pygeum papuanum Hemsley, Kew Bull. 1898 (1901) 99. — Type: *Giulianetti* (via McGregor) s.n., Mt Scratchley.

Pygeum rigidum Koehne, Bot. Jahrb. 52 (1915) 339. — Type: *Ledermann* 11453, Papua New Guinea, not seen.

Pygeum retusum Merr. & Perry, J. Arnold Arbor. 21 (1940) 195. — Types: *Brass* 9035, holo; *Brass & Meijer Drees* 10428, 10439; all Lake Habbema.

Pygeum hagenianum Gilli, Ann. Naturhist. Mus. Wien 83 (1980) 455; Kalkman, Blumea 28 (1982) 168 (reduction). — Types: *Dosedla* 129B, holo; 145; both Mt Hagen.

Shrubs or small trees, up to 25 m, buttresses not reported, bark grey to brown, finely fissured and lenticelled. *Twigs* glabrous or sparsely hairy when young. *Leaves* elliptic to oblong, 3–13(–16) by 2–7 cm, base usually rounded, apex obtuse or bluntly acuminate, often retuse, stiff coriaceous, 6–10(–14) pairs of nerves, venation impressed above, inconspicuous below, puberulous only when young, both sides glabrous when mature, basal glands (0–)2–4, flat. *Petiole* up to 1 cm long. *Stipules* oblong, 2.5–9 by 1.2–3.5 mm, free. *Racemes* solitary, in axils of extant or fallen leaves, (4–)5–12(–15) cm long, peduncle short, rachis sparsely hairy, pedicels 1–4 mm long, longer under the fruit. *Hypanthium* 2–3(–4) mm high, sparsely hairy to almost glabrous outside. *Perianth* regularly 4- to 6-merous, sometimes irregular, hairy outside. *Sepals* triangular to ovate, 1–2 mm long. *Petals* ovate to elliptic, 1–3 mm long, white. *Stamens* 20–35, filaments up to 5.5 mm, anthers 0.5–1 mm long. *Ovary* glabrous, style up to 4 mm long. *Fruits* transversely ellipsoid, 6–10 by 8–11.5 mm, fruiting calyx (i.e. lower part of hypanthium) saucer- to cup-shaped, 3–5 mm diam., exocarp glabrous, red to purplish, endocarp usually hairy inside. *Seed* with hairy testa.

Distribution — Throughout New Guinea.

Habitat — Forest and also more open subalpine habitats like thickets, altitude 1500–3700 m.

Uses — Bark used for making waistbands (like other species of the genus).

Notes — The species is very similar to *Prunus grisea* var. *grisea* and differs only in the indumentum of the seeds, which is considered to be an important, usually decisive character for species delimitation. When in flower, the two species can hardly or not be distinguished. The indumentum of the hypanthium may give a clue: less hairy in *costata*.

11. *Prunus dolichobotrys* (K. Schum. & Lauterb.) Kalkman, Blumea 13 (1965) 75. — *Pygeum dolichobotrys* K. Schum. & Lauterb., Fl. Schutzgeb. Südsee (1901) 340; Nachtr. (1905)

274. — Type: *Rodatz & Klink 168*, Bismarck Mts, fragment of holotype in WRS�, neotypification (*Schlechter 14700*) in Kalkman, l.c., was not necessary.

Combretum flavovirens Lauterb., Nova Guinea 8 (1912) 847. — Type: *Gjellerup 577*, Humboldt Bay.

Trees up to 30 m, buttresses small or absent, bark brown, lenticelled, peeling off in thin flakes. *Twigs* glabrous, often lenticelled. *Leaves* elliptic to ovate, (8–)12–26 by 5–12(–15) cm, base rounded to subcordate, apex rounded to broadly acuminate, herbaceous, with 7–14 pairs of nerves, venation transverse, not conspicuous, both sides entirely glabrous, basal glands 2–4(–6), flat or slightly hollowed. *Petiole* up to 1.5(–2) cm long. *Stipules* linear to linguiform, 5.5–7.5 by 1.5–2.2 mm, keeled inside and often intrapetiolarly connate, glabrous, sometimes ciliolate. *Racemes* solitary, axillary, (3–)5–21(–33) cm long, peduncle up to 1.5 cm, some empty bracts at the base, rachis glabrous or sparsely puberulous, pedicels 1.5–5 mm long. *Flowers* sometimes functionally male, cream-coloured. *Hypanthium* 2–3 mm high, (almost) glabrous outside. *Perianth* differentiated, (4–)5-merous. *Sepals* triangular, 0.8–1.5 mm long, glabrous except sometimes apex and margin. *Petals* elliptic to obovate, 1–2 mm long, usually more hairy than sepals. *Stamens* 10–30, filaments up to 6 mm, anthers 0.8–1.5 mm long. *Ovary* glabrous, style up to 4.5 mm long, pistillodium in male flowers small. *Fruits* transversely ellipsoid to didymous, 8–11.5 by 11–15 mm, exocarp glabrous, black when ripe, mesocarp thin, juicy, endocarp glabrous inside. *Seed* with glabrous testa. — **Fig. 19.**

Distribution — Throughout New Guinea, including the Papuan Islands to the East, and also in the Bismarck Archipelago (New Britain, New Ireland).

Habitat — Primary and secondary forest, often on riverbanks, altitude 0–1000(–1800) m.

Uses — Hardly ever reported by collectors. *Dornstreich 76* (E Sepik Prov.): wood used for smaller house poles, bark for making eel traps, leaves to flavour soup or cooked greens.

12. *Prunus fragrans* (Elmer) Kalkman, *Blumea* 13 (1965) 74. — *Pygeum fragrans* Elmer, *Leafl. Philipp. Bot.* 2 (1908) 475; 5 (1913) 1622; Merr., *Enum. Philipp. Flow. Pl.* 2 (1923) 232. — Type: *Elmer 7504*, lecto, Luzon.

Parinarium coccineum Elmer, *Leafl. Philipp. Bot.* 2 (1909) 578. — *Pygeum coccineum* (Elmer) Elmer, *Leafl. Philipp. Bot.* 5 (1913) 1621. — Type: *Elmer 9787*, Negros.

Pygeum megaphyllum Elmer ex Merr., *Philipp. J. Sc., Bot.* 10 (1915) 312. — Type: *Ramos BS 14923*, Luzon.

Small trees, up to 15 m. *Twigs* sparsely hairy when young. *Leaves* elliptic or elliptic-ovate, more rarely oblong, (10–)12–19(–23) by 4.5–10(–13) cm, base usually rounded, sometimes shortly decurrent, rarely acute, apex usually acuminate, herbaceous to ± coriaceous, with 6–10 pairs of nerves, sparsely pubescent on both sides, basal glands 2, hollowed and bulging on upper side, other foliar glands often also hollowed. *Petiole* 1–2.5 cm long. *Stipules* oblong, 4–8 by 1.5–3 mm, free, with glandular margin. *Racemes* solitary, in axils of extant or fallen leaves, up to 8 cm long, in fruit up to 14 cm, peduncle short, rachis hairy, pedicels 1.5–4(–5) mm long. *Flowers* bisexual or (rarely) male. *Hypanthium* 2.5–3.5 mm high, densely hairy outside. *Perianth segments* 7–13, subequal, up to 1.5(–2.5) mm long, hairy. *Stamens* 25–55, glabrous, filaments up to 7 mm, anthers 0.5–0.7 mm long. *Ovary* glabrous or with few hairs, style up to 6.5 mm long, also with some hairs or glabrous. *Fruits* ellipsoid, 24–30 by 15–17 mm, exocarp glabrous, black when ripe, mesocarp thick and fleshy, hard when dry, endocarp sparsely hairy inside. *Seed* with glabrous testa.

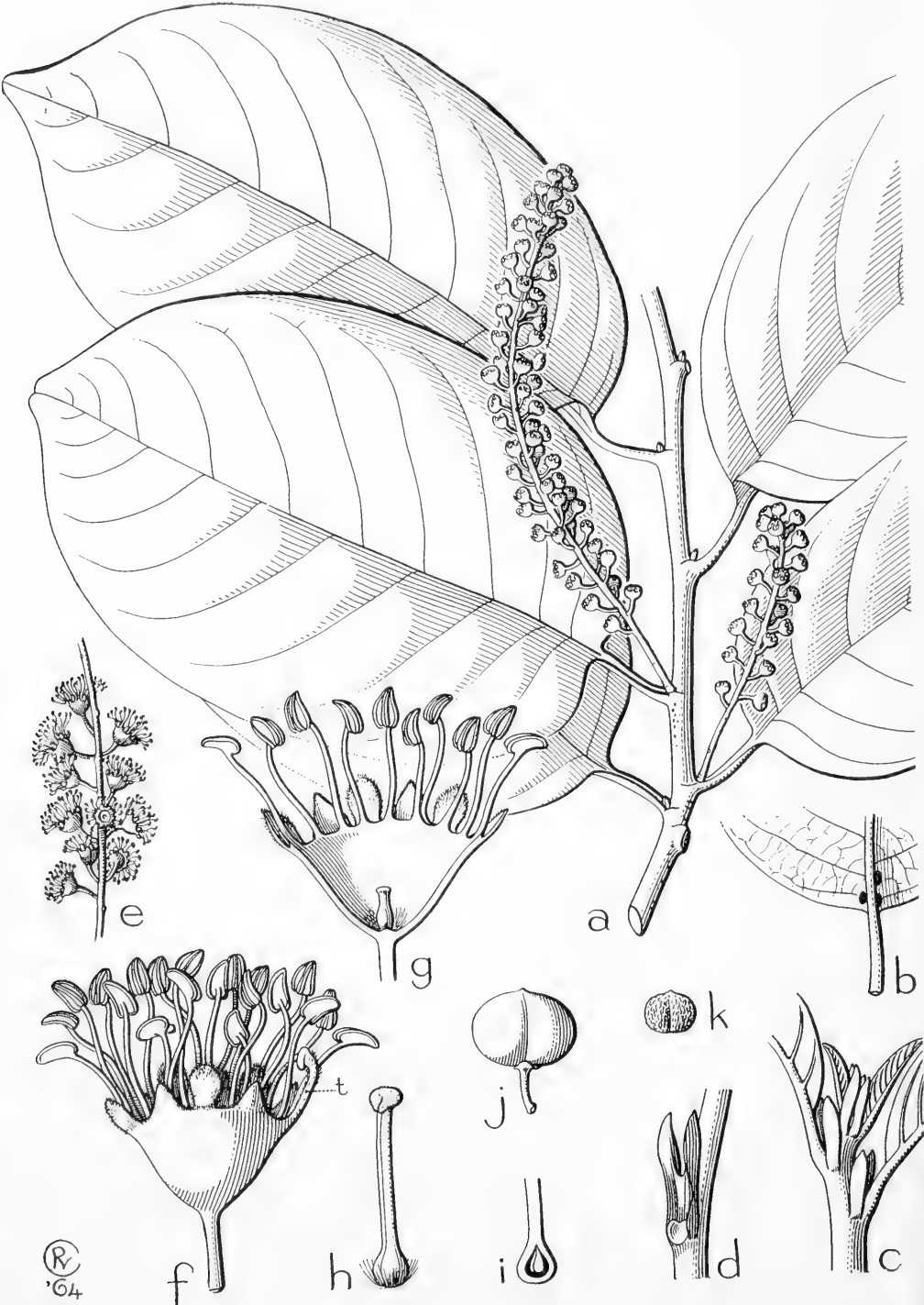
Distribution — Philippines, seen from Camiguin, Luzon, Mindoro, Panay, and Negros. T.C. Huang, *Checklist in Fl. Taiwan* 6 (1979) 63, mentions the species (as *Pygeum megaphyllum*) for Taiwan, which is quite plausible. I saw a sterile collection (*C.E. Chang 3080*) from Lanyu (Botel Tobago), a small island off the SE coast of Taiwan. This specimen may belong to *P. fragrans*, although identification remains a bit doubtful.

Habitat — Primary and secondary forest (few data), altitude 150–2500 m.

13. *Prunus gazelle-peninsulae* (Kaneh. & Hatus.) Kalkman, *Blumea* 13 (1965) 77. — *Pygeum gazelle-peninsulae* Kaneh. & Hatus., *Bot. Mag. Tokyo* 52 (1938) 355, f. 1 ('*gazelle-peninsulium*'). — Type: *Kanehira 3966*, New Britain.

Pygeum platyphyllum K. Schum. in K. Schum. & Lauterb., *Fl. Schutzgeb. Südsee, Nachtr.* (1905) 273. — Type: *Nyman 593*, 'Sattelberg', Papua New Guinea.

Trees up to 37 m, buttresses absent or small spurs, bark brown to grey-brown, smooth or shallowly fissured, flaking. *Twigs* hairy, glabrescent, older twigs usually lenticelled. *Leaves* elliptic to



ovate, rarely oblong, (10–)12–25 by 6–14 cm, base rounded to subcordate, apex rounded or shortly acuminate, herbaceous, with 9–14(–17) pairs of nerves, venation transverse, both sides more or less densely hairy when young and indumentum not quite disappearing with age, basal glands mostly 4, flat to slightly hollowed. *Petiole* up to 1.5(–2) cm. *Stipules* triangular to ovate, 3–6.5 by 1.2–2.5 mm, keeled inside and often intrapetiolarly connate in the lower half, hairy outside and on margins. *Racemes* solitary, in axils of extant or fallen leaves, 5–16 cm long, peduncle very short, pedicels usually not longer than 1 mm, hairy as is the rachis. *Flowers* bisexual or male. *Hypanthium* 2.5–4 mm high, densely hairy outside. *Perianth* regular, 5-merous. *Sepals* triangular to linguiform, 1–2 mm long, densely hairy. *Petals* elliptic to oblong, 1–2 mm long, also hairy, cream-coloured. *Stamens* 18–40, filaments up to 8 mm, glabrous, anthers up to 1.5 mm long. *Ovary* glabrous except at very base, style up to 6 mm long, pistillode in male flowers small to minute. *Fruits* transversely ellipsoid, 8–12 by 11–17 mm, fruiting calyx (basal part of hypanthium) saucer-shaped, 2–3.5 mm diam., exocarp glabrous, black when ripe, mesocarp fleshy, endocarp mostly hairy inside. *Seed* with hairy testa.

Distribution — Moluccas (one flowering specimen seen from Ceram), throughout New Guinea, and Bismarck Archipelago (New Britain).

Habitat — Primary and secondary forest, altitude 0–1600(–2100) m.

Ecology — “Birds feed upon the fruits” (*Sayers* 21333).

Note — When fruits are absent, distinguishable from the very similar *Prunus dolichobotrys* by the indumentum of the leaves and on the exterior of the hypanthium.

14. *Prunus glabrifolia* Kalkman, *Blumea* 13 (1965) 64; Prance & Whitmore in *Tree Fl. Malaya* 2 (1973) 338. — *Pygeum brevifolium* Hook. f., *Fl. Brit. India* 2 (1878) 321; Ridley, *Fl. Mal. Pen.* 1 (1922) 676. — Types: *Griffith* 2051, *holo*; *Lobb s.n.*; both Mt Ophir, Malaya.

Pygeum scortechinii King, *J. As. Soc. Beng.* 66, 2 (1897) 290; Ridley, *Fl. Mal. Penins.* 1 (1922) 674. — Type: *Scortechini* 357, Perak.

Shrubs or trees up to 15 m. *Twigs* hairy, soon glabrescent. *Leaves* elliptic to oblong or ovate, 3.5–7.5(–11) by 1.5–4(–5) cm, base acute to rounded, apex acute to acuminate, coriaceous, with 4–7 pairs of nerves, venation inconspicuous, both sides entirely glabrous when mature, basal glands 2, flat. *Petiole* up to 1 cm long. *Stipules* oblong to narrowly triangular, 1.5–4 by 0.5–1.5 mm, free, with 1–3 flat or pustular glands on the surface (only seen in Malayan specimens) and sometimes (also) with marginal glands. *Racemes* solitary, axillary, up to 1 cm long, with up to 6 flowers, in fruit up to 3.5 cm, peduncle 0, pedicels 0–2 mm long. *Hypanthium* 1.5 mm high, hairy outside. *Perianth segments* 6–9, subequal, less than 1 mm long, hairy. *Stamens* 12–20, filaments up to 3.5 mm, glabrous or with hairs at base, anthers up to 0.7 mm long. *Ovary* densely hairy at least in lower part, style up to 2.5 mm, hairy or glabrous. *Fruits* transversely ellipsoid, 6–9 by (7–)8.5–12.5 mm, exocarp sparsely hairy, colour unknown, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — W Sumatra, Malaya (mountains in Perak, Selangor, Malacca, Johore), Borneo (Sarawak, dubious specimen from Sabah).

Habitat — Both Sumatran specimens and 2 out of 5 Bornean specimens come from limestone hills, no notes about the substrate on the 7 specimens from Malaya. The altitude varies from 650 to 1800 m.

Notes — In 1965 the species was only seen from Malaya and Sumatra; it has now also been collected in the Gunung Mulu National Park, Sarawak. A dubious specimen comes from Mt Kinabalu, Sabah.

The species differs from the rather similar *Prunus grisea* var. *tomentosa* in the stiff and hard (not papyraceous) leaves.

The epithets *brevifolia* and *scortechinii* were used previously in *Prunus*.

Fig. 19. *Prunus dolichobotrys* (K. Schum. & Laut.) Kalkman. a. Twig with young racemes, $\times 0.7$; b. Basal leaf glands, $\times 0.7$; c, d. stipules, $\times 1$, $\times 2$; e. male flowers, $\times 0.7$; f, g. male flower, from outside and halved lengthwise, $\times 4$ (t = transition petal–stamen); h, i. pistil from bisexual flower, $\times 4$; j. fruit, $\times 1$; k. seed, $\times 1$ (a, b, e: *Hoogland* 3966, c, d: *Brass* 7308; f, g: *Womersley* NGF 3700; h–k: *Darbyshire* & *Hoogland* 8249).

15. *Prunus grisea* (Blume) Kalkman, *Blumea* 13 (1965) 56; Prance & Whitmore in *Tree Fl. Malaya* 2 (1973) 337. — *Pygeum griseum* Blume, *Mél. Bot.* nr. 2 (1855) 11; C. Muell. in *Walp.*, *Ann.* 4 (1857) 642. — Type: *Kuhl & van Hasselt s.n.*, L sheet 908.197-535, Java. Blume, *Mél. Bot.* was effectively published in 1855, see Van Steenis, *Taxon* 35 (1986) 272–285. *Pygeum griseum*, therefore, does not have Blume ex C. Mueller in Walpers as its author, but simply Blume.

Germaria latifolia Presl, *Epim. Bot.* (1851) 221. — *Pygeum preslii* Merr., *Philipp. J. Sc.*, *Bot.* 3 (1908) 227; Elmer, *Leaf. Philipp. Bot.* 5 (1913) 1621. — *Pygeum latifolium* (Presl) Rehder, *Bradl. Bibliogr.* 2 (1912) 278, comb. illeg. — Type: *Cuming 1815*, Bohol, Philippines.

Pygeum latifolium Miq., *Pl. Jungh.* (1855) 401; *Fl. Ind. Bat. I*, 1 (1855) 361; Koord. & Valetton, *Bijdr. Booms. Java* 5 (1900) 355, incl. varieties; Koord., *Exk. Fl. Java* 2 (1912) 336; *Atlas* 1 (1913) pl. 114, 115. — Type: *Junghuhn 107*, Java.

Pygeum preslii Merr. var. *vulgare* Koehne, *Bot. Jahrb.* 51 (1913) 203. — *Pygeum vulgare* (Koehne) Merr., *Enum. Philipp. Flow. Pl.* 2 (1923) 234. — Type: *Borden FB 1806*, Luzon.

Pygeum melanocarpum Merr. & Perry, *J. Arnold Arbor.* 21 (1940) 191. — Types: *Brass 11532*, holo; *Brass 11531*, *Brass & Versteegh 10480*; all Irian Jaya.

Pygeum arboreum (Blume) Blume, p.p.: Backer & Bakh.f., *Fl. Java* 1 (1964) 520.

For more complete synonymy, see Kalkman, l.c.

Trees or shrubs. *Twigs* hairy but rapidly glabrescent. *Leaves* elliptic to oblong, or ovate to lanceolate, 2–20 by 1–9 cm, base rounded or acute, apex various, usually 5–9 pairs of nerves, venation inconspicuous to invisible, sparsely pubescent to glabrous on both sides, basal glands usually 2, flat. *Petiole* 0.2–1.5(–2) cm long. *Stipules* 1.5–8 by 0.2–1.8 mm, free. *Racemes* solitary, in axils of extant or fallen leaves, 0.5–6.5(–9) cm long, peduncle 0–1 cm, pedicels 0–7 mm long. *Hypanthium* 1.5–4 mm high, (sparsely) hairy outside. *Perianth segments* 6–13, subequal or more or less distinctly differentiated, 0.5–2 mm long. *Stamens* 15–50, filaments up to 6 mm, anthers 0.2–0.8 mm long. *Ovary* usually glabrous, sometimes with some hairs, rarely distinctly hairy, style up to 7 mm long. *Fruits* transversely ellipsoid to globular, 6–13 by 7–16 mm, sometimes pointed or beaked and larger (see note under var. *tomentosa*), exocarp

(almost) glabrous, via whitish and red turning purple and finally black, mesocarp thin, endocarp glabrous or sparsely hairy inside. *Seed* with glabrous testa.

Distribution — Peninsular Burma, Thailand, Vietnam; throughout *Malesia*, var. *grisea* more in the eastern part, var. *tomentosa* more to the west, var. *microphylla* endemic to New Guinea.

KEY TO THE VARIETIES

- 1a. Racemes 0.5–1(–2.5) cm, dense, pedicels 0–2 mm. Leaves thin, papyraceous
c. var. **tomentosa**
- b. Racemes 1.5–6.5(–9) cm, loose, pedicels 1–7 mm. Leaves herbaceous or coriaceous . . . 2
- 2a. All or at least most of the full-grown leaves shorter than 7 cm . . . b. var. **microphylla**
- b. All or at least most of the full-grown leaves longer than 9 cm a. var. **grisea**

a. var. **grisea** — Kalkman, *Blumea* 13 (1965) 58. The synonyms given above under the species pertain to the type variety.

Trees up to 40 m, bark different shades of brown, smooth or lenticellate. *Leaves* elliptic to oblong or ovate to lanceolate, (5–)9–20 by 2.5–9 cm, apex long-tapering to acuminate, rarely obtuse, herbaceous or coriaceous, basal glands (0–)2(–4). *Racemes* 1.5–6.5(–9) cm, pedicels 1–7 mm. *Hypanthium* 2–4 mm high. *Perianth segments* subequal, sometimes (especially in New Guinea) more or less regularly divided into sepals and petals, up to 2 mm long. *Ovary* glabrous, rarely with some hairs, in Java and Lesser Sunda Islands rarely densely hairy. *Fruits* transversely ellipsoid to globular, 6–13 by 8–16 mm, hypanthium remnant under the fruits up to 2 mm across, but in New Guinea 3–5 mm.

Distribution — Java, Kangean, Philippines, Celebes, Lesser Sunda Islands, Moluccas, New Guinea. According to the literature also on Taiwan. In Java and Palawan this variety overlaps with var. *tomentosa*, in New Guinea with the endemic var. *microphylla*.

Habitat — Primary and secondary forest, mostly between sea-level and 2500 m altitude, but especially in New Guinea often higher (up to 3400 m altitude), see below.

Notes — The New Guinean plants differ in several respects from the plants in Celebes and the Philippines: their perianth is sometimes larger and somewhat regularly divided in sepals and petals (those differing in shape but hardly in size), the

'calyx' (remnant of hypanthium) under the fruit is large, and the leaves are generally thick and hard. In New Guinea the collections come from (370–) 1200–3400 m altitude, collections from the Philippines often bear no data on altitude, but only two collections were seen from altitudes higher than 800 m. Also in Celebes all (rather few) collections come from below 1000 m. However, the morphological differences are very gradual and characters overlap very much. When two separate varieties were distinguished, identification would usually only rest on geography and altitude.

The shapes and dimensions of the fruits show geographical variation: in New Guinea fruits are smallest (up to 9 mm long, up to 12 mm wide), in Java they are also short but often wider (7–10 by 10–15 mm), in the Philippines fruits are largest (8–14 mm long, 9–16 mm wide), with the fewer specimens from Celebes and the Moluccas falling within this range. Some specimens from Palawan have fruits at the extreme end of the variation and these specimens (*Manalo* FB 7424, *Ridsdale* 182, 191, *Soejarto & Fernando* 7381) can only be distinguished from *Prunus kinabaluensis* by their foliar glands, see note under that species.

As mentioned under *Prunus costata*, that species and the present variety are much alike, among other characters by their thick and hard leaves and by the large fruiting calyx (hypanthium remnant). Flowering specimens cannot always be identified with certainty.

b. var. *microphylla* Kalkman, *Blumea* 13 (1965) 63. — Type: *Sleumer & Vink* 14250, Irian Jaya.

Usually small trees (rarely over 20 m) or shrubs, bark rough, brown to grey. *Leaves* elliptic to elliptic-oblong, (1.5–)2–6(–8.5) by 1–3(–5) cm, apex obtuse or retuse, stiff-coriaceous, basal glands 2 or 4. *Racemes* 2–5 cm, pedicels 1–4 mm. *Hypanthium* 1.5–3(–3.5) mm high. *Perianth segments* usually subequal, sometimes regularly divided into sepals and petals, 0.5–1.5 mm long. *Ovary* glabrous. *Fruits* transversely ellipsoid to subglobular, 6–9 by 7–10.5 mm, hypanthium remnant under the fruits sometimes large, 1.5–5 mm.

Distribution – Throughout New Guinea.

Habitat – Montane and subalpine forest, altitude 1400–3660 m.

Uses – One collector (*Robbins* 845) noted the use of the bark for belts, also known for other species.

Note – This is not just a high altitude form of var. *grisea*. Both varieties occur at the same altitudes and within var. *microphylla* the dimensions

of the leaves are not at all correlated with altitude. The only differences with var. *grisea* are in the leaf dimensions and transitional specimens are few.

c. var. *tomentosa* (Koord. & Valeton) Kalkman, *Blumea* 13 (1965) 60. — *Pygeum latifolium* Miq. var. *tomentosum* Koord. & Valeton, *Bijdr. Booms. Java* 5 (1900) 358. — Type: *Koorders* 22255, lecto, Java.

Pygeum maingayi Hook. f., *Fl. Brit. India* 2 (1878) 319. — *Pygeum lanceolatum* Hook. f. var. *maingayi* (Hook. f.) Ridley, *Fl. Mal. Penins.* 1 (1922) 674. — Type: *Maingay* 625, Malaya.

Pygeum hookerianum King, *J. As. Soc. Beng.* 66, 2 (1897) 293; Ridley, *Fl. Mal. Penins.* 1 (1922) 676. — Type: *Wray* 3969, Malaya.

Small trees (rarely over 15 m) or shrubs, bark brown. *Leaves* ovate or elliptic to oblong, 4–14 by 1.5–6 cm, apex (long-)acuminate, paperyaceous, basal glands (0–)2(–4). *Racemes* up to 1(–2.5) cm long, pedicels 0–2 mm. *Hypanthium* 1.5–2(–3) mm high. *Perianth segments* 7–10, subequal, rarely more or less regularly differentiated as sepals and petals, up to 1.3 mm long. *Ovary* usually glabrous, sometimes sparsely hairy, rarely more densely hairy. *Fruits* transversely ellipsoid with obtuse apex, to subglobular with an apical point or beak of up to 1(–2) mm, 7–12 by 8–12.5(–13.5) mm (and see note below).

Distribution – Peninsular Burma, Peninsular and SE Thailand, Vietnam; in *Malesia*: N Sumatra, throughout Malaya incl. Penang, Singapore, Borneo (only Sabah, Sarawak), C and E Java, Philippines (Palawan only), Celebes (only one specimen seen from Mt Nokilalaki, 1500–1700 m altitude).

Habitat – Primary and secondary forest, altitude 0–1300(–1650) m.

Note – This variety is normally not difficult to recognize by its thin leaves and short racemes. A group of (five) collections from Sarawak, mostly from riverbanks, stands out by having identical leaves but quite different fruits: those are compressed globular to ovoid, 13–21 by 10–15 by 8–11 mm, with a prominent apical beak of up to 4 mm. These fruits are rather similar to those of *Prunus lamponga*, which has, however, different leaves. The taxonomic status of this Sarawak group remains unsolved as yet.

See also under the insufficiently known *Prunus odorata* (p. 349).

16. *Prunus kinabaluensis* Kalkman, *Blumea* 13 (1965) 64. — Type: *Clemens* 29527, Mt Kinabalu.

Small trees up to 15 m, bark smooth, pale green to brown. *Twigs* glabrous. *Leaves* elliptic to elliptic-oblong, 6–12 by 2.5–5.5 cm, base acute to rounded, apex usually gradually tapering, firm-herbaceous, with 5–7 pairs of nerves, venation inconspicuous, both sides glabrous, basal glands 0–6, usually more than 2, large, flat, all or part of them above the base in the blade. *Petiole* 0.5–1.5 cm long. *Stipules* oblong, free, 3.5–5.5 by 0.8–2 mm, ciliolate and sometimes with marginal glands. *Racemes* solitary, axillary, 2–6 cm long, peduncle up to 1 cm, rachis sparsely hairy, pedicels up to 3 mm long. *Hypanthium* 2–3 mm high, densely short-hairy to almost glabrous outside. *Perianth segments* 7–12, not regularly differentiated as sepals and petals, triangular to elliptic or ovate, 1–2 by 0.7–1 mm, cream-coloured to white, densely hairy to glabrous. *Stamens* 24–32, filaments up to 4 mm, glabrous, anthers up to 0.5 mm long. *Ovary* glabrous, style up to 4 mm long. *Fruits* (sub)globular, 12–14 by 13–16 mm, exocarp black when ripe, endocarp glabrous or hairy inside. *Seed* with glabrous or sparsely hairy testa.

Distribution – Borneo (only seen from Sabah, Ranau District), Philippines (only seen from Luzon).

Habitat – Forest, at altitudes between 1300 and 2400 m.

Note – Since the description of this species in 1965, more specimens have been collected in Sabah, but it is now also known from two collections from Luzon. The large foliar glands positioned above the base remain a conspicuous character of *P. kinabaluensis* and by this character it is distinguishable from the large-fruited specimens of *P. grisea* var. *grisea* that occur on some Philippine islands, especially on Palawan.

17. *Prunus lamponga* (Miq.) Kalkman, Blumea 13 (1965) 66; Prance & Whitmore in *Tree Fl. Malaya* 2 (1973) 338. — *Pygeum lampongum* Miq., *Ann. Mus. Bot. Lugd.-Bat.* 1 (1864) 212. — Type: *Teijsmann HB 4434*, Sumatra.

Pygeum goethartianum Koehne, *Bot. Jahrb.* 51 (1913) 191. — Type: *Korthals s.n.*, Sumatra. *Pygeum gracilipes* Koehne, *l.c.* 191. — Type: *Korthals 126*, Sumatra.

Pygeum coriifolium Ridley, *J. Str. Br. Roy. As. Soc.* 75 (1917) 30; *Fl. Mal. Penins.* 1 (1922) 675. — Type: *Ridley 14614*, lecto; 14616; both Malaya.

Small trees, rarely more than 15 m high, bark smooth, brown or greyish. *Twigs* sparsely hairy only when very young. *Leaves* elliptic to oblong,

7–18(–21) by 3–6(–9) cm, base acute to rounded, margin often somewhat revolute, apex (usually shortly) acuminate, herbaceous, with 4–9(–11) pairs of nerves, often rather wide apart, venation usually almost invisible, glabrous on both sides when mature, puberulous only when very young, rarely more permanently short-hairy on both sides, basal glands 2(–4), flat. *Petiole* up to 1 cm long. *Stipules* linear, 3–7 by 0.5–1 mm, free, sometimes with marginal glands. *Racemes* solitary, in axils of extant or fallen leaves, up to 2.5 cm long, peduncle very short, rachis shortly hairy, pedicels 0–2 mm long. *Flowers* sometimes male. *Hypanthium* 1.7–3 mm high, sparsely hairy outside. *Perianth segments* 7–12(–15), subequal or at least not regularly differentiated as sepals and petals, up to 1 mm long, (sparsely) hairy outside. *Stamens* 17–32(–40), filaments up to 4 mm, glabrous, anthers up to 0.5 mm long. *Ovary* sparsely to densely hairy, rarely glabrous, style up to 4 mm long. *Fruits* ellipsoid to (compressed) subglobular, 13–24 by 10–20 (by 12–14) mm, the length including an apical point or more distinct beak of 1–4 mm length, exocarp usually sparsely hairy, rarely glabrous, rarely densely hairy, colour unknown, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution – Malaya, Sumatra, Bangka, Borneo.

Habitat – Primary and secondary forest of different types, altitudes from sea-level up to c. 850 (–1500) m.

Notes – See the note under *P. grisea* var. *tomentosa* for a comparison with a group of specimens from Sarawak, which have fruits matching the present species, but different leaves.

Recently collected specimens have not supported the recognition of a variety with more hairy and also large leaves, as suggested in Kalkman, *l.c.* The transitions to small and glabrous leaves are gradual.

18. *Prunus lacinervis* Kalkman, Blumea 13 (1965) 69. — Type: *Clemens 28477*, Borneo.

Trees up to 18 m. *Twigs* sparsely hairy. *Leaves* elliptic to oblong, 10–18 by 5–8 cm, base acute to rounded, apex acuminate, herbaceous, with 7–9 pairs of nerves, arcuating at some distance from the margin, venation inconspicuous, both sides (almost) glabrous, basal glands 2, flat. *Petiole* up to 1.3 cm long, hairy to glabrous. *Stipules* narrowly triangular, 4.5–7 by 1–2 mm, free. *Racemes* solitary, axillary, up to 5 cm long, peduncle very short, rachis hairy, pedicels 1–3 mm long. *Hypan-*

thium 1.5–3 mm high, hairy outside. *Sepals* 4, triangular, up to 1.5 mm long, hairy outside. *Petals* 4, ovate, up to 1.5 mm long, sometimes thinner than sepals, hairy, cream-coloured. *Stamens* 25–40, filaments up to 3 mm, glabrous, anthers c. 0.5 mm long. *Ovary* densely hairy, style up to 4 mm long. *Fruits* subglobose, 11–13 by 12–14 mm, exocarp sparsely hairy, colour unknown, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — Only known from Borneo, Sabah (several collections from Mt Kinabalu and two slightly deviating ones from other districts).

Habitat — Forest, 1000–1830 m altitude (also lower?).

19. *Prunus malayana* Kalkman, Blumea 13 (1965) 102; Prance & Whitmore in Tree Fl. Malaya 2 (1973) 338. — Type: *Nur SFN 32695*, Malaya.

Trees up to 30 m, buttresses none or short, bark grey to brown, smooth or lenticellate. *Twigs* hairy when young. *Leaves* elliptic, 12–22 by 6–13 cm, base truncate to subcordate, apex obtuse to shortly and bluntly acuminate, herbaceous, with 9–15 pairs of nerves, venation indistinct, upper side glabrous, lower side shortly hairy and glabrescent, basal glands usually 2, large, flat or slightly hollowed and bulging above, sometimes glands absent. *Petiole* up to 1.5 cm long. *Stipules* pointed ovate, 3–5 (–11) by 2–4 mm, connate over up to 1 mm by their excentric, keeled midribs. *Racemes* compound, in axils of extant or fallen leaves, 5–10 cm long, with 1–5 laterals up to c. 7 cm, peduncle c. 1 cm, rachis hairy, pedicels up to 2.5 mm long. *Flowers* sometimes male, sex disposition in trees unknown. *Hypanthium* 2–3 mm high, shortly hairy outside, with long hairs at base inside. *Perianth* differentiated as sepals and petals, but these only differing in shape, not in size, 5–6-merous. *Sepals* triangular, c. 1 mm long. *Petals* elliptic, c. 1 mm long, densely hairy. *Stamens* 50–80, filaments up to 4.5 mm, glabrous, anthers c. 0.5 mm long. *Ovary* glabrous or with some few hairs, style up to c. 3 mm long, pistillodium in male flowers minute, hidden in the hairs on the bottom of the hypanthium. *Fruits* ellipsoid to (rarely) subglobose, 18–25 by 16–21 mm, exocarp glabrous, colour when ripe unknown, endocarp glabrous or sparsely hairy inside. *Seed* with glabrous testa or with few hairs especially near apex.

Distribution — Peninsular Malaysia: Pahang, Trengganu, Perak.

Habitat — Forest, primary or disturbed, at altitudes from c. 100 to c. 1200 m.

Note — This species is, by its large leaves and compound racemes similar to *Prunus polystachya*, and is obviously closely related. The main difference is in the fruits (ellipsoid vs. transversely ellipsoid) and in flower the two are not always easy to distinguish. See also under Insufficiently known species, *Prunus A.*

20. *Prunus marsupialis* Kalkman, Blumea 13 (1965) 71. — *Pygeum glandulosum* Merr., Philipp. J. Sc., Bot. 3 (1908) 226; Elmer, Leaflet Philipp. Bot. 5 (1913) 1621; Merr., Enum. Philipp. Flow. Pl. 2 (1923) 233. — Types: *Williams 642*, lecto; 25 syntypes; all Philippines.

Pygeum pubescens Merr., Philipp. J. Sc., Bot. 9 (1914) 359. — Type: *Wenzel 333*, lecto; 5 paratypes; all Philippines.

Small trees up to 13 m. *Twigs* hairy when young. *Leaves* elliptic to oblong, or somewhat ovate, (6–)8–13 (–16) by 3–6.5 cm, base rounded to acute, apex obtuse to acuminate, herbaceous, with 5–8 pairs of nerves, venation reticulate to more or less transverse, usually not conspicuous, both sides pubescent when young, glabrate, basal glands normally 2, hollowed and distinctly bulging above, rarely absent. *Petiole* up to 1 cm long. *Stipules* linear, free, often persistent, 4–12 (–17) by 0.5–3 mm, with marginal glands. *Racemes* solitary, in axils of extant or fallen leaves, up to 7 (–10.5) cm long, peduncle short, rachis hairy, pedicels up to 1.5 (–3.5) mm long. *Hypanthium* c. 2 mm high, densely hairy outside. *Perianth segments* 8–12, subequal, up to 1.5 mm long, hairy. *Stamens* 20–30 (–40), filaments up to 5 mm, glabrous, anthers 0.3–0.4 mm long. *Ovary* densely hairy, style up to 4 mm long, base hairy. *Fruits* transversely ellipsoid, 6–13 by 7.5–15 mm, exocarp still sparsely hairy, via red ultimately becoming black, endocarp glabrous or with some hairs inside. *Seed* with glabrous testa. — **Fig. 20.**

Distribution — Philippines, many islands from north to south, but not (yet) seen from Mindanao and Palawan. T.-C. Huang, Checklist in Fl. Taiwan 6 (1979) 63, mentions the species for Taiwan, from where I have not seen any specimens.

Habitat — Forest and forest edges, from sea-level to c. 1100 m altitude.

Note — Both epithets published in *Pygeum* are not available in *Prunus*.

21. *Prunus oligantha* Kalkman, Blumea 13 (1965) 83. — Type: *Hooiland & Pullen 5439*, Papua New Guinea.



Fig. 20. *Prunus marsupialis* Kalkman. a. Flowering twig, $\times 0.7$; b. basal leaf glands, $\times 2$; c, d. flower, from outside and halved lengthwise, $\times 4$; e. fruits, $\times 0.7$ (Loher 2225).

Small trees, rarely over 15 m high, sometimes shrubs, bark dark brown or grey. *Twigs* hairy. *Leaves* oblong to ovate-oblong, 4–11(–14) by 1–4 cm, base acute, rarely rounded, apex acute to acuminate, coriaceous, with 5–8 pairs of nerves, venation invisible, densely hairy when young, hairs persistent on lower side, basal glands 0(–2), small, flat. *Petiole* up to 1 cm long. *Stipules* narrowly triangular, 2.5–5 by 1–1.5 mm, free, with marginal glands. *Racemes* solitary, axillary, up to 1 cm long, in fruit no longer than 2 cm, rachis densely hairy. *Flowers* up to 10, sessile, yellowish. *Hypanthium* 2–3 mm high, hairy outside. *Perianth segments* subequal, 6–12, 1–1.5 mm long. *Stamens* 12–30, filaments up to 2.5 mm, glabrous or hairy at base, anthers c. 0.5 mm long. *Ovary* densely hairy, style up to 3 mm long, sometimes hairy at base. *Fruits* ellipsoid or subglobular, 10–13 by 8–11 mm, exocarp still hairy when ripe, red, turning black when ripe, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — New Guinea, only one collection seen from Irian Jaya.

Habitat — Primary or disturbed montane forest, at 1500–2900 m altitude.

Uses — The bark is used for making waist-belts (*Clunie & Katik LAE 63312, Vink 16519*), as reported for other species too.

22. *Prunus oocarpa* (Stapf) Kalkman, *Blumea* 13 (1965) 102. — *Pygeum oocarpum* Stapf, *Trans. Linn. Soc. Bot.* 4 (1894) 144; Merr., *Enum. Born. Flow. Pl.* (1921) 289. — Type: *Haviland 1118*, Mt Kinabalu.

Shrubs or trees up to 15 m. *Twigs* densely hairy when young and rather tardily glabrescent. *Leaves* ovate to elliptic-ovate, 4–10(–13) by 3–6 (–8) cm, base rounded to cordate, sometimes decurrent, margin often revolute, apex rounded to obtuse, thick and coriaceous, with 7–11 pairs of nerves, venation slightly impressed above, flat underneath, densely hairy when very young, hairs disappearing with age, leaving the surfaces distinctly pitted and midrib above usually still hairy, basal glands 2(–4), flat to slightly hollowed and bulging above. *Petiole* up to 0.5 cm long, rarely longer. *Stipules* triangular, 3–5 by 2–3 mm, free. *Racemes* solitary, simple or with 1(–2) side-branch(es) at very base, in axils of extant or (more rarely) fallen leaves, up to 3(–5) cm long, peduncle absent, rachis hairy, pedicels up to 2 mm long. *Hypanthium* 1.5–2 mm high, densely and rather long hairy outside. *Perianth segments* (sub)equal, 7–11, 1–2 by 0.3–0.7 mm, densely hairy, brown-

ish to yellowish. *Stamens* 11–18(–21), filaments up to 2.5 mm, anthers 0.3–0.5 mm long. *Ovary* densely long-hairy, style 2–3 mm long, sometimes hairy at base. *Fruits* ellipsoid, 8–11 by 6–8 mm, hairy, red when ripe (?), endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — Borneo, known from Sabah (Mt Kinabalu, Mt Trusmadi), Brunei (Mt Pagon Periok), and Sarawak (Mt Api).

Habitat — Mossy forest and other types of forest, often on mountain ridges, also in shrubland, reported from limestone as well as from ultramafic soil and from sandstone, alt. 1200–3000 m.

Note — This species is quite homogeneous in appearance. It resembles some specimens of *P. arborea* var. *alticola*, but differs in the shape of the fruits: transversely ellipsoid and nearly always broader than long, rarely subglobular, in var. *alticola*, ellipsoid and always longer than wide in *P. oocarpa*. Flowering specimens are sometimes more difficult to distinguish, but var. *alticola* has more and often longer stamens (16–40, filaments up to 6 mm). The crater-like glands that sometimes occur on the stipules of var. *alticola*, were not seen in *P. oocarpa*.

23. *Prunus polystachya* (Hook. f.) Kalkman, *Blumea* 13 (1965) 88; Prance & Whitmore in *Tree Fl. Malaya* 2 (1973) 339; Corner, *Wayside Trees of Malaya* ed. 3, 2 (1988) 619, pl. 199. — *Pygeum polystachyum* Hook. f., *Fl. Brit. India* 2 (1878) 320; Ridley, *Fl. Mal. Penins.* 1 (1922) 674. — Type: *Maingay 627*, Malacca. *Pygeum myriandrum* Merr., *Pap. Mich. Acad. Sc.* 19 (1934) 155. — Type: *Bartlett 6871*, Sumatra.

Deciduous trees, up to 35 m high and more than 60 cm diam., sometimes with buttresses, bark grey to black or blackish brown. *Twigs* hairy only when young. *Leaves* elliptic to elliptic-ovate, 8–26 by 5–15 cm, base rounded to truncate, rarely acute, apex obtuse or shortly acuminate, herbaceous to coriaceous, with 9–12(–14) pairs of nerves, venation inconspicuous, glabrous on both sides, finely pubescent below only when very young, basal glands 0(–2), deeply hollowed, distinctly bulging above, not rarely in the contracted leaf-base. *Petiole* 0.5–1.5 cm long. *Stipules* narrowly triangular to oblong, oblique, 4–10 by 1.5–3 mm, usually free, rarely shortly intrapetiolarly connate. *Racemes* solitary, mainly in the basal part of shoots and appearing with the flush of new leaves, in the axils of leaves or in kataphylls below the leaves, or united into pseudo-panicles (leafless shoots usually retaining their terminal bud) or fascicled by contrac-

tion of the main axis, or truly compound with some side-branches and without terminal bud, 3.5–11 cm long, rachises short-hairy, pedicels 1–3 mm long. *Flowers* sometimes male, fragrant. *Hypanthium* 2–3 mm high, shortly hairy outside. *Perianth segments* 7–11, subequal or unequal but only rarely by their shape somewhat regularly differentiated as sepals and petals, 1–1.5 mm long, hairy. *Stamens* 50–85, filaments up to 5 mm, glabrous, anthers 0.3–0.7 mm long. *Ovary* glabrous except around insertion, or with some long hairs higher up, often on one side only, rarely more densely hairy, style 4–5 mm long, pistilodium in male flowers minute. *Fruits* transversely ellipsoid, 13–21 by 17–27 mm, exocarp glabrous, remaining green when mature (?), endocarp glabrous inside. *Seed* with glabrous or hairy testa.

Distribution – Sumatra (only seen from the middle part), Malaya, Singapore, Borneo? (From this island only one collection was seen, viz. *Forman & Blewett* 946, Brunei; it has the typical large leaves and fruits of this species but deviates in having flat instead of marsupial basal leaf glands).

Habitat – Primary and secondary forest, altitude 0–600 m.

Ecology – Corner, l.c., records pollination by “crowds of hover-flies and small beetles”, attracted by the fragrant flowers. He invented the queer English name “bat’s laurel” for the species but the role of bats was not elucidated.

Notes – See Kalkman, *Blumea* 13 (1965) 9, fig. 4, for a discussion of the morphology of the inflorescence in this species.

Closely related is *Prunus malayana*, see the note under that species. See also under Insufficiently known species, *Prunus A.*

24. *Prunus pulgarensis* (Elmer) Kalkman, *Blumea* 13 (1965) 67. — *Pygeum pulgarens* Elmer, *Leaflet Philipp. Bot.* 5 (1913) 1627; Merr., *Enum. Philipp. Flow. Pl.* 2 (1923) 234. — Type: *Elmer 13200*, Palawan.

Pygeum monticolum Merr., *Philipp. J. Sc.*, Bot. 10 (1915) 312. — Type: *Whitford 1203*, Luzon.

Small trees. *Twigs* densely hairy. *Leaves* elliptic to oblong or ovate, 7–14 by 3–5.5 cm, base acute or rounded, apex acuminate, coriaceous, with 6–9 pairs of nerves, venation reticulate, impressed above, inconspicuous below, densely hairy when young, lower surface remaining hairy when mature, basal glands 2–4 or absent, flat. *Petiole* 0.5–1.2 cm long. *Stipules* elliptic, c. 3–4.5 by 1–2 mm, free. *Racemes* solitary, in axils of extant or fallen leaves, up to 5.5 cm long, peduncle absent, rachis

densely hairy, pedicels up to 1 mm long. *Hypanthium* 2–2.5 mm high, densely hairy outside. *Perianth segments* subequal, 8–10, up to 2 mm long, densely hairy. *Stamens* 25–35, filaments up to 5 mm, glabrous or hairy at base, anthers c. 0.5 mm long. *Ovary* densely hairy. *Fruits* globular, 14–18 mm diam., exocarp hairy, mesocarp thick and hard when dry, endocarp thin, glabrous inside. *Seed* with glabrous testa.

Distribution – Philippines (Luzon, Palawan).

Habitat – Mountain forest, c. 1000–1200 m altitude.

Note – Little known species and no new material added to what was known in 1965.

25. *Prunus pullei* (Koehne) Kalkman, *Blumea* 13 (1965) 85. — *Pygeum pullei* Koehne, *Bot. Jahrb.* 52 (1915) 338. — Type: *Pulle 1005*, Irian Jaya.

Prunus pullei (Koehne) Kalkman var. *grandiflora* Kalkman, *Blumea* 13 (1965) 86. — Type: *Pullen 252*, Papua New Guinea.

Small trees, up to 15(–24) m, in higher altitudes usually treelets of some metres or large shrubs, bark brown, usually rough and lenticellate, sometimes grey. *Twigs* densely hairy. *Leaves* elliptic to oblong, 2–12 by 1.5–5 cm, base acute to rounded, margins often revolute also when living, apex obtuse, often retuse, stiff-coriaceous, with 5–9 pairs of nerves, distinctly looped and joined near the margin, densely hairy when young and usually still hairy below when mature, basal glands 2(–4), flat. *Petiole* 0.2–1 cm long. *Stipules* narrowly triangular, 2.5–7 by 0.7–1.8 mm, free. *Racemes* solitary, in axils of extant or fallen leaves, 1–12 cm long, peduncle 0–1.5 cm, rachis densely hairy, pedicels 0–7 mm long. *Hypanthium* 2–4 mm high, densely hairy outside. *Perianth segments* 8–12, subequal or unequal but not regularly differentiated as sepals and petals, 1–2 mm long, hairy outside. *Stamens* 15–40, filaments up to 7 mm, glabrous or with some hairs at base, anthers 0.4–1 mm long. *Ovary* densely hairy, style up to 5 mm long, sometimes hairy at base. *Fruits* subglobular to transversely ellipsoid, 6–11 by 7–11.5 mm, exocarp hairy, shining purplish black when ripe, endocarp glabrous or with some hairs inside, calyx (i.e. remnant of hypanthium) under the fruit 1.5–4 mm diam., but in specimens from high altitudes up to 8 mm diam. *Seed* with glabrous testa.

Distribution – New Guinea.

Habitat – All kinds of montane forest, also mossy forest, and in subalpine shrubland, at (1500–) 2000–3700 m altitude.

Uses — As for other species, there are a few reports (Bowers 843, Pullen 252) of the use of the bark for making men's waist belts.

Notes — Herbarium material has more than doubled since 1965 and it has become clear that the earlier distinction of two varieties (Kalkman, l.c.) cannot be upheld. Leaf and flower characters are not really correlated and intermediates occur frequently. The infraspecific variation of course remains. Large leaves (more than 8 cm in length) are only found in lower altitudes (below 3000 m), but there is not a real correlation of leaf size and altitude since small leaves (up to 7 cm long) occur throughout the altitudinal range. The distinctness of the nervation underneath depends much on the size of the leaves: larger leaves often have more prominent nerves. The size of the flowers, i.e., the hypanthium, and correlated with it the size of the fruiting calyx, is variable but a boundary can only arbitrarily be drawn. There is a tendency that larger flowers especially occur in higher altitudes.

26. *Prunus rubiginosa* (Elmer) Kalkman, Blumea 13 (1965) 72. — *Pygeum rubiginosum* Elmer, Leaf. Philipp. Bot. 5 (May 1913) 1624; Merr., Enum. Philipp. Fl. Pl. 2 (1923) 234. — Type: *Elmer 11857*, holo; *14067*; both Mindanao.

Pygeum elmerianum Koehne, Bot. Jahrb. 51 (Dec. 1913) 206; Merr., Enum. Philipp. Fl. Pl. 2 (1923) 232. — Type: *Elmer 12210*, Sibuyan.

Trees up to c. 17 m, bark dark brown, smooth (few reports only). *Twigs* rapidly glabrescent. *Leaves* elliptic to oblong, 7–15.5 by 3–7.5 cm, base acute or rounded and decurrent, apex gradually narrowing or subacuminate, herbaceous, with 7–10 pairs of nerves, venation not conspicuous, sparsely hairy to glabrous, basal glands 1–2, distinctly hollowed and bulging above. *Petiole* 0.5–1.5 cm long. *Stipules* 3–6 by 1–1.8 mm, free, hairy, with marginal glands. *Racemes* solitary, in axils of extant or fallen leaves, 2–7 cm long, peduncle very short, rachis hairy, pedicels 0–1 mm long. *Hypanthium* 2.5–3 mm high, hairy outside. *Perianth segments* 10–12, not regularly differentiated as sepals and petals, up to 2 mm long. *Stamens* 60–75, filaments c. 3.5 mm, glabrous, anthers 0.3–0.5 mm long. *Ovary* more or less hairy, style c. 5 mm long. *Fruits* compressed subglobular to obscurely transversely ellipsoid, 16–17 by 16–20 mm, exocarp almost glabrous, red turning purple, mesocarp leathery-fleshy, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — Philippines, known from Luzon, Mindoro, Sibuyan, and Mindanao, but in each island only from 1 or 2 collections.

Habitat — Forest, altitude 250–1200 m.

Note — Young fruits seem to be ellipsoid.

27. *Prunus schlechteri* (Koehne) Kalkman, Blumea 13 (1965) 79. — *Pygeum schlechteri* Koehne, Bot. Jahrb. 51 (1913) 210. — Type: *Schlechter 17621*, Papua New Guinea.

Pygeum forbesii Koehne, l.c. 210. — Type: *Forbes 529*, Papua New Guinea.

Pygeum laurocerasus Koehne, l.c. 208. — Type: *Schlechter 18621*, Papua New Guinea.

Pygeum tetradenum Koehne, Bot. Jahrb. 52 (1915) 341. — Type: *Ledermann 7889*, Papua New Guinea.

Pygeum salomonense Merr. & Perry, J. Arnold Arbor. 21 (1940) 196. — Type: *Brass 2727*, San Cristóbal.

Trees up to 35 m, sometimes buttressed, bark (dark to greyish) brown, smooth or shallowly fissured and with vertical lines of lenticels. *Twigs* sparsely to densely hairy. *Leaves* elliptic to oblong, rarely ovate, 6–17(–20) by 2–8(–10) cm, base rounded to acute, apex tapering or acuminate, herbaceous to coriaceous, with 6–13 pairs of nerves, venation usually inconspicuous, sparsely to densely hairy when young, upper surface becoming (almost) glabrous, lower surface usually still hairy when mature, basal glands (0–)2–6, flat. *Petiole* 0.2–1 cm long. *Stipules* ovate to triangular, 2.5–6(–14) by 1–2.5 mm, free, usually with marginal glands. *Racemes* solitary, mostly in axils of fallen leaves, 1.5–7(–15) cm long, peduncle short, rachis densely hairy, pedicels 0–2(–4) mm long. *Flowers* fragrant, sometimes male. *Hypanthium* 1.5–3 mm high, hairy outside. *Perianth segments* subequal and not regularly differentiated as sepals and petals, 7–13, up to 2 mm long. *Stamens* 15–40, filaments up to 5 mm, glabrous or hairy at base, anthers 0.5–1 mm long. *Ovary* densely hairy, style up to 3 mm long, often hairy, pistillode in male flowers minute, hairy. *Fruits* transversely ellipsoid to subglobular (see note), in New Guinea and New Ireland 9–16 by 9–18 mm, in the Solomon Islands up to 17.5 mm long and 20(–23) mm wide, usually hairy, purplish black when ripe, mesocarp often rather thick, endocarp glabrous or with few hairs inside. *Seed* with hairy testa, sometimes hairs only near the hilum.

Distribution — New Guinea, Bismarck Archipelago (New Ireland), Solomon Islands (from Bougainville to San Cristóbal).

Habitat – Primary and secondary forest, in New Guinea from sea-level to c. 2600(–2800) m altitude, in the Solomon Islands not above 1200 m.

Uses – Few reports on medicinal use are known only from the Solomon Islands (*Kajewski* 2383, 2483): a macerate of the bark is applied to aching teeth and sore legs.

Notes – In New Guinea one could distinguish two groups differing in the shape and size of the fruits:

- I Mature fruits transversely ellipsoid, sometimes distinctly bilobed, 10–13 by 12–18 mm. Seen from low altitudes, up to 1220 m.
- II Mature fruits (sub)globular, 9–16 by 9–16 mm. Seen from higher altitudes, (1280–)1680–2620 m.

The two groups overlap in the measurements of their fruits and the distinction in shape is not always evident: the (sub)globular fruits of group II may tend to be transversely ellipsoid. Moreover, the characters of leaves and flowers do not show any correlation with the differences in fruit and flowering material cannot be matched with the groups as based on the fruits.

The few specimens seen from New Ireland fit in with group I. The populations from the Solomon Islands have, as mentioned in the description, fruits reaching larger sizes than the New Guinean plants of group I, but with an ample overlap.

The shape, size, and consistency of the leaves are somewhat variable in this species without, however, permitting the distinction of infraspecific taxa.

Some specimens with exceptionally long racemes and large leaves may resemble *P. dolichobotrys*, but differ in the hairy ovaries, fruits, and seeds.

28. *Prunus sclerophylla* Kalkman, Blumea 13 (1965) 67. — Type: *Robbins* 573, Papua New Guinea.

Small to medium-sized trees or shrubs. *Twigs* densely hairy. *Leaves* elliptic to oblong, or ovateish, 1.5–7 by 1–3 cm, base acute, apex acute or shortly acuminate, coriaceous, with 4–7 pairs of nerves, venation not conspicuous, hairy when young, glabrescent but remaining hairy underneath, basal glands 0–2, flat. *Petiole* 0.2–0.5 cm long. *Stipules* narrowly triangular, 3–4 by 0.7–1 mm, free. *Racemes* solitary, in axils of extant or fallen leaves, up to 2.5 cm long, peduncle up to 0.5 cm, rachis hairy, pedicels up to 2.5 mm long. *Hypanthium* 2–2.5 mm high, densely hairy out-

side. *Perianth segments* subequal or at least not regularly differentiated as sepals and petals, 10–12, 1–1.5 mm long, hairy. *Stamens* 18–28, filaments up to 3 mm, glabrous, anthers 0.5 mm long. *Ovary* glabrous or with few hairs especially near suture, style up to 2.5 mm long. *Fruits* transversely ellipsoid, 6–8 by 7–9.5 mm, exocarp glabrous, black when ripe, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution – Papua New Guinea, seen from a number of mountains in W and E Highlands Provinces.

Habitat – Forest, also mossy forest, and sub-alpine shrubland, altitudes 2100–3100 m.

Uses – The bark of larger trees is, like that of other species of *Prunus*, used for native waist-belts (*Pullen* 148, Mt Hagen area).

Note – The extremely limited value of recording vernacular names is well illustrated by the three different names for this species, given in the course of two weeks by one or more informants speaking the Minj language to one collector, *R. Pullen* (5197 yurih, 5226 beindangan, 5329 bugl-bakl)!

29. *Prunus spicata* Kalkman, Blumea 13 (1965) 69. — Type: *Clemens* 40755, Sabah.

Trees up to 12(–25) m, or large shrubs, bark dark purplish or brownish. *Twigs* densely hairy. *Leaves* elliptic to oblong or lanceolate to ovate, 6–18 by 2.5–6.5 cm, base rounded, apex acute, long tapering or acuminate, herbaceous, with 6–12 pairs of nerves, venation inconspicuous to invisible, (rather) densely hairy when young, hairs usually remaining underneath, basal glands 0–2 (–4), flat. *Petiole* 0.2–1 cm long. *Stipules* narrowly triangular to oblong, 3–8 by 0.5–2.5 mm, free, rather persistent, margin hairy, with glands. *Racemes* solitary, axillary, 1–10(–17) cm long, peduncle 0–0.5 cm, rachis hairy, pedicels 0–1 mm long. *Flowers* sometimes male. *Hypanthium* 1.5–3 mm high, densely to sparsely hairy outside. *Perianth segments* subequal or at least not regularly differentiated as sepals and petals, 8–10, 0.5–2 mm long, hairy. *Stamens* 15–30, filaments up to 4 mm, glabrous or sparsely hairy at base, anthers 0.3–0.5 mm long. *Ovary* densely hairy, style up to 4.5 mm long, often partly hairy, pistillode in male flowers minute. *Fruits* globular to transversely ellipsoid, 9–14.5 by 9–14.5 mm, exocarp hairy to almost glabrous, red when ripe (becoming black?), endocarp glabrous inside. *Seed* with glabrous testa.

Distribution – Borneo, Philippines (Luzon, a sterile specimen from Mindoro).

Habitat — Primary (and secondary?) forest, also on riverbanks, at 1100–1500 m altitude.

Note — Judging from the c. 8 fruiting specimens seen, the fruits in Luzon are more globular, those in Borneo more transversely ellipsoid and average-sized somewhat smaller.

30. *Prunus subglabra* (Merr.) Kalkman, Blumea 13 (1965) 87. — *Pygeum subglabrum* Merr., Philipp. J. Sc. 30 (1926) 395. — Type: *Ramos & Edaño BS 45014*, Mt Pulog.

Small trees up to 7 m. *Twigs* sparsely hairy when young. *Leaves* elliptic, 6–10 by 4–5 cm, base acute, apex shortly acuminate, coriaceous, with 6–8 pairs of nerves, venation inconspicuous, sparsely hairy when young, glabrescent, basal glands 0–2, flat or slightly hollowed but not bulging above. *Petiole* 0.5–1.5 cm long. *Stipules* elliptic, c. 8 by 3–4 mm, free, keeled inside, sparsely hairy outside. *Racemes* solitary, in axils of extant or fallen leaves, 2–5 cm long (in fruiting stage), rachis stout, hairy, fruit pedicels up to 3 mm long. *Flowers* only known from some old fragments. *Hypanthium* c. 3 mm high, densely hairy outside. *Perianth segments* subequal, c. 9(?), c. 2 mm long. *Stamens* c. 45, filaments up to 3.5 mm, anthers c. 0.5 mm long. *Ovary* hairy, probably densely so. *Fruits* subglobular, 15–20 by (?12–)17–19 mm, exocarp with few hairs, red, endocarp sparsely hairy inside. *Seed* with glabrous testa.

Distribution — Luzon: only seen from Mt Pulog and nearby Mt Tabayog.

Habitat — Forest, one collection from mossy forest, altitude 2400–2700 m.

Note — Two recent collections are both in fruit and do not add to the incomplete information on the flowers of this still badly known species, of which only three collections seem to exist, although Mt Pulog on Luzon is a well-explored place.

31. *Prunus turfosa* Kalkman, Blumea 13 (1965) 90. — Type: *Anderson 13123*, Sarawak.

Small trees up to 12 m, rarely buttressed, bark grey, smooth or slightly rough. *Twigs* sparsely hairy or glabrous. *Leaves* elliptic to oblong, 8–13(–18) by 4–6.5 cm, base acute, rarely rounded, apex obtuse to acuminate, herbaceous, with 8–12 pairs of nerves, venation inconspicuous, sparsely hairy to entirely glabrous, basal glands 2, deeply hollowed, in the contracted leaf-base. *Petiole* 0.5–1 cm long. *Stipules* not seen. *Racemes* in fascicles

of up to 4, in axils of extant or fallen leaves, up to 3.5 cm long, peduncle less than 0.5 cm, rachis hairy, pedicels 1.5–2 mm long. *Hypanthium* 1.7–2.5 mm high, sparsely hairy outside. *Perianth segments* subequal, 5–8, up to 1 mm long. *Stamens* 15–30, filaments up to 3.5 mm, glabrous or slightly hairy at base, anthers 0.2–0.5 mm long. *Ovary* sparsely hairy (to entirely glabrous?), style up to 4.5 mm long. *Fruits* subglobular, 7–9 by 8–9 mm, exocarp with some hairs or glabrous, colour unknown, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution — Borneo: Sarawak, Kalimantan (one collection from W Kalimantan, near the border with Sarawak), Brunei [according to Anderson, Check-list Trees Sarawak (1980) 295, but specimens not seen].

Habitat — Peat swamp forest, about sea-level.

Note — New data about this species are not available and it seems that there has not been done any collecting in the habitat of *Prunus turfosa* after 1961.

32. *Prunus turneriana* (F.M. Bailey) Kalkman, Blumea 13 (1965) 81. — *Pygeum turnerianum* F.M. Bailey, Bot. Bull. Queensl. Dep. Agr. 8 (1893) 75; Queensl. Fl. 2 (1900) 525, pl. 19. — Type: *Cowley s.n.*, Queensland.

Prunus glomerata (Koehne) Kalkman, Blumea 13 (1965) 81. — *Pygeum glomeratum* Koehne, Bot. Jahrb. 52 (1915) 340. — Type: *Ledermann 9497*, Papua New Guinea.

Trees up to 30 m, sometimes slightly buttressed, bark smooth or with lenticels in longitudinal lines, brown to grey. *Twigs* hairy, glabrescent. *Leaves* elliptic to ovate or obovate, 7–23 by 4–11 cm, base rounded to acute, apex acute to rounded, coriaceous to herbaceous, with 7–12(–15) pairs of nerves, venation more or less transverse, usually conspicuous beneath when dry, densely to sparsely hairy when young, glabrescent, basal glands 2–6, flat. *Petiole* 0.5–1.5 cm long. *Stipules* ovate to triangular, sometimes large, 4–7(–15) by 1–3(–10) mm, free. *Racemes* solitary, in axils of extant or fallen leaves, 2–9 cm long, peduncle absent or very short, rachis hairy, pedicels 0–2 mm long. *Flowers* often male. *Hypanthium* (2–)3–4 mm high, hairy outside and also inside. *Perianth* subequal to more or less regular, 6–14, up to 1.5 mm long. *Stamens* 15–50, filaments up to 4.5 mm, often hairy at base, anthers 0.5–1.2 mm long. *Ovary* hairy, style up to 5 mm long, hairy, pistilode in male flowers minute. *Fruits* compressed subglobular, 17–33 by 18–34 mm, hairy, black

when ripe, mesocarp rather thick when living, endocarp c. 1 mm thick, woody, usually hairy inside. *Seed* with usually sparsely hairy testa, hairs often especially near apex, sometimes glabrous, rarely densely hairy.

Distribution – Moluccas (one specimen seen from Bacan), Papua New Guinea (and one sterile collection from Irian Jaya), Bismarck Archipelago (only one specimen, from New Hanover), Australia (N Queensland).

Habitat – Forest, from sea-level to 2400 m altitude.

Notes – The species is characterized by its thick-walled, compressed subglobular fruits. In Australia the species is much more uniform than in New Guinea, but on the evidence available now, it is not possible to discriminate two taxa, as done in the 1965 revision. In New Guinea the species is found at low altitudes (as in Queensland) but also in montane forest. In the higher altitudes the leaves are often relatively small and densely hairy, but the variation in these two characters is continuous.

The fruits are very variable in dimension, also within one specimen; the extremely large fruits all come from New Guinea. The indumentum on the seedcoat is in Australian specimens usually sparse and often restricted to the apex. In New Guinean specimens the seeds are sometimes quite glabrous, rarely densely hairy.

33. *Prunus versteeghii* Kalkman, Blumea 13 (1965) 104. — Type: *Versteegh BW 4843*, Irian Jaya.

Trees up to 25 m, buttresses sometimes present, bark grey(-brown), strongly smelling. *Twigs* sparsely hairy to glabrous. *Leaves* oblong to oblong-ovate, 10–15 by 4–8 cm, base rounded to acute, apex acute, herbaceous, with 7–9 pairs of nerves, venation not conspicuous, glabrous to very sparsely hairy, basal glands 2, flat. *Petiole* 0.7–1 cm long. *Stipules* (few seen) c. 6 by 2 mm, free. *Racemes* solitary or in fascicles of 2–3, in axils of extant or fallen leaves, 3–10 cm long, peduncle very short, rachis hairy, pedicels 1–2 mm long. Only male flowers seen. *Hypanthium* c. 2 mm high, hairy outside. *Sepals* triangular, c. 1 mm long,

hairy. *Petals* elliptic to obovate, c. 1 mm long, hairy. *Stamens* 35–45, filaments 1.5 mm, anthers 0.5–0.7 mm long. *Pistillode* in male flowers minute, ovary in bisexual flowers probably hairy. *Fruits* transversely ellipsoid to didymous, 15–19 by 22–28(–30) mm, exocarp sparsely hairy to glabrous, purplish black when ripe, mesocarp rather thick, endocarp glabrous inside. *Seed* with glabrous testa.

Distribution – New Guinea, seen from five localities far apart.

Habitat – Forest, probably preferring wet places. Altitude 0–300 m.

34. *Prunus wallaceana* Kalkman, Blumea 13 (1965) 86. — Type: *Kostermans 18587*, Sumbawa.

Trees up to 30 m, rarely buttressed, bark smooth, grey to dark brown, with lenticels. *Twigs* hairy to glabrous. *Leaves* elliptic to oblong, sometimes ovate, 10–18 by 4–8 cm, base usually rounded, rarely more acute, apex gradually tapering to shortly acuminate, herbaceous, with 8–14 pairs of nerves, venation widely transverse, not conspicuous, usually glabrous, rarely with some pubescence, basal glands (0–)2, flat. *Petiole* (0.5–)1–2.5 cm long. *Stipules* oblong, 3–9 by 0.8–2.3 mm, free, sometimes slightly keeled inside, sometimes with marginal glands. *Racemes* solitary, in axils of extant or fallen leaves, 4–10 cm long, peduncle very short, rachis sparsely hairy, pedicels (0.5–)3–6 mm long. *Hypanthium* 2–3 mm high, (sparsely) hairy outside. *Perianth* 5- or 6-merous. *Sepals* triangular, 1–1.5 mm long, hairy outside. *Petals* obovate, 1.5–3 mm long, hairy outside, white. *Stamens* 35–55, filaments up to 4.5 mm, glabrous or hairy at base, anthers 0.3–0.7 mm long. *Ovary* glabrous, style up to 6 mm long. *Fruits* transversely ellipsoid, 10–13 by 13–18 mm, exocarp glabrous, red when ripe (or ultimately becoming black?), endocarp glabrous inside. *Seed* with glabrous testa.

Distribution – Celebes (S peninsula, Talaud I.), Lesser Sunda Islands (seen from Sumbawa, Sumba, Flores), Moluccas (seen from Ternate, Ceram).

Habitat – Primary and secondary forest, also along rivers, altitude 0–1700 m.

Subgenus *Padus*

See under Insufficiently known species, *Prunus C.*

Subgenus *Amygdalus*

In Malesia only cultivated.

***Prunus persica* (L.) Batsch, Beitr. Entw. Pragm. Gesch. 1 (1801) 30.** — *Amygdalus persica* L., Sp. Pl. (1753) 472. — *Persica vulgaris* Miller, Gard. Dict. (1768) 465. — Type: in LINN.

Deciduous shrubs or trees, up to 8 m. *Twigs* glabrous. *Leaves* lanceolate, 5–8(–15) by 1.5–2 cm, margin serrate, basal glands on top of petiole or at base of blade in the margin. *Flowers* appearing before the leaves, often in pairs next to axillary buds, 5-merous, pedicels 0. *Petals* pink. *Stamens* 35–40. *Ovary* hairy to glabrous. *Fruits* globular, faintly furrowed longitudinally, 3–8 cm diam., exocarp hairy (peach) or glabrous (nectarine),

yellow to red, mesocarp fleshy, yellow to red, endocarp thick and hard, deeply pitted and furrowed.

Distribution – Native in China, cultivation spread from there, now cultivated wherever the climate is suitable. In Malesia rarely cultivated in montane areas, among others in East Java.

Uses – Fruits edible and according to many one of the world's most delicious table fruits. See information on aspects of cultivation in tropical Asia: S. Subhadrabandhu in E.W.M. Verheij & R.E. Coronel (eds.), *Edible fruits and nuts*, Plant Res. SE Asia (PROSEA Handbook) 2 (1991) 262–266.

Common names – Peach, nectarine (English), Persik (Indonesia, Malaysia), Peras (Philippines).

INSUFFICIENTLY KNOWN SPECIES

***Prunus odorata* (Henderson) Whitmore in Tree Fl. Malaya 2 (1973) 338.** — *Pygeum odoratum* Henderson, Gard. Bull. Str. Sett. 7 (1933) 101, pl. 20. — Type: *Henderson SFN 23278*, Malaya.

Small trees. *Twigs* glabrous. *Leaves* ovate-elliptic, 6.5–11 by 3.5–5.5 cm, base rounded to acute, apex acute to acuminate, herbaceous, with 6–9 pairs of nerves, venation inconspicuous, glabrous, basal glands 2–4, flat. *Petiole* 0.5–1 cm long. *Stipules* 4 by 1 mm, free. *Racemes* solitary, up to 4 cm long, rachis hairy, pedicels up to 5 mm long. *Flowers* fragrant (*Henderson SFN 23278*). *Hypanthium* c. 2.5 mm high, hairy outside. *Perianth segments* subequal, 7–9, 1–1.2 mm long. *Stamens* 28–38, filaments up to 5 mm long. *Ovary* hairy, style up to 5 mm long, hairy at base. *Fruits* not seen.

Distribution – Malaya, Pahang, Cameron Highlands.

Habitat – Nothing known except the altitude: 1440 m.

Note – Although now formally transferred from *Pygeum* to *Prunus*, this taxon – if it is one – has not become better known than in 1965, when I put it under the ‘incompletely known species’, only flowers and flowerbuds being present on the two collections. There is a distinct likeness to *Prunus grisea* var. *tomentosa*.

Prunus A

Trees up to 25 m high and 30 cm diam., bark light to darkbrown, smooth. *Twigs* practically glabrous. *Leaves* elliptic, 14–17 by 8–10 cm, base rounded to truncate, rarely more acute, apex shortly acuminate to rounded, herbaceous, with 8–10 pairs of nerves, venation transverse, not very conspicuous, glabrous above, sparsely short-hairy below, basal glands 2, deeply hollowed and bulging above, situated in a contraction of the leaf-basae. *Petiole* 1–1.5 cm long. *Stipules* ovate, sometimes oblique, 6–9 by 1.5–3 mm, free(?), with glands on margin and (often?) with 1–3 flat to slightly hollowed glands on the outer surface, sparsely hairy outside. *Inflorescence* a compound raceme, in axils of leaves or scars, up to 10 cm long, with up to 4 side-branches of 4–6 cm long, rachis sparsely short-hairy, pedicels up to 1 mm long. *Flowers* sometimes male. *Hypanthium* 1.5–2 mm high, hairy outside. *Perianth segments* 8–10, subequal, 0.5–1 by 0.2–0.5 mm, hairy outside. *Stamens* 20–25, filaments up to 3.5 mm, glabrous or with few hairs at base, anthers 0.2 mm long. *Ovary* glabrous, style up to 4 mm long, pistillode in male flowers small. *Fruits* (only young ones seen) probably globular or transversely ellipsoid, 8 by 10 mm when immature, glabrous. *Seed* with glabrous testa (when young).

Distribution — Borneo, seen from Sarawak and Sabah.

Habitat — Forest on hillsides and riverbanks, up to 450 m altitude.

Note — The leaves of the six collections, here indicated as *Prunus* A (belonging to sect. *Mesopygeum*), are of the same kind as those of *Prunus polystachya*, having the large marsupial glands in a contraction of the leaf-base.

The young fruits present on three of the specimens do certainly not give the impression that they could grow into the large fruits as in *malayana* or *polystachya*.

Prunus B — *Pygeum macropetalum* Koehne, Bot. Jahrb. 51 (1913) 198, 222; Baker f., J. Bot. 62 (1924) Suppl. 33. — Types: *Forbes* 2343, 2354a, Sumatra, Mt Dempo.

Trees. *Twigs* glabrous. *Leaves* ovate-lanceolate to elliptic or oblong, 8–17 by 3.5–9 cm, base acute to rounded, apex tapering to acuminate, coriaceous, with 10–15 pairs of nerves, venation transverse, not conspicuous, both surfaces glabrous when mature, sparsely hairy below when very young only, basal glands 0–2, flat. *Petiole* 1–2 cm long. *Stipules* 7–8.5 by 2–3 mm, free, glabrous, margin glandular. *Racemes* solitary, in the axils of fallen leaves, 7–15 cm long, peduncle 1–2 cm long, rachis hairy, pedicels 4–8 mm long, pink. *Hypanthium* 3–4 mm high, short-hairy outside. *Perianth* differentiated as sepals and petals, but not rarely with irregularities, 4- or 5-merous. *Sepals* triangular, 1.5–2 mm long, hairy outside. *Petals* suborbicular to elliptic, 2–3.5 mm long, hairy outside, white. *Stamens* 35–55, filaments up to 7 mm, glabrous or with some hairs at base, anthers 0.7–1 mm long. *Ovary* glabrous, style up to 5 mm long. *Fruits* subglobose-ovoid, 10–12 mm long, see note. *Seeds* with glabrous testa.

Distribution — Sumatra, see note. Part of *Forbes* 2354a has 'Java' printed on the labels.

Habitat — Altitude 1700–2000 m.

Note — The two specimens cited with the original description seem to be conspecific with *De Wilde & De Wilde-Duyffes* 14087 from Mt Ketambe and with the sterile specimen *Meijer* 6434 from Mt Kerinci, both also from Sumatra but rather wide apart. The species belongs to sect. *Mesopygeum* and is obviously related to *Prunus grisea* and *P. ceylanica*, but the very long racemes and the rather large flowers are differentiating. It is entered here because of the insufficient data on the fruits. The description given rests on the field note of *De Wilde c.s.* 14087, but on the herbarium

specimens only some immature fruits are present and a possibly full-grown one which is subglobose and measures 8 by 7 mm, with some few hairs.

Prunus C — *Prunus luzoniensis* Merr. & Quis., nomen on herbarium sheet.

Small trees. *Twigs* glabrous. *Leaves* lanceolate, 8–10.5 by 2.5–3 cm, base acute, margin finely serrate, apex gradually narrowed, herbaceous, with c. 15 pairs of nerves, between two primary nerves often with an \pm equally strong and parallel nerve, venation not conspicuous, upper surface glabrous, lower surface with hairs on and near midrib, domatia absent, basal glands usually 2, on the top of the petiole. *Petiole* 1–1.5 cm long. *Stipules* narrowly triangular, 9–10 by 1–1.5 mm, free, on the twig, both sides hairy, margin dentate-glandular. *Racemes* terminal on lateral branches, bearing two normal but small (up to 7.5 cm long) leaves in the part below the flowers, entire branch 9–13 cm long, with c. 20 flowers, rachis hairy, pedicels 2–3 mm long. *Hypanthium* c. 2.5 mm high, sparsely hairy outside. *Sepals* 5, triangular with rounded apex, c. 1.5 by 1.5–2 mm, margin with some glandular teeth, (almost) glabrous outside. *Petals* 5, broadly obovate, 3–4 by 3.5–4.5 mm, glabrous, white. *Stamens* c. 20, filaments up to 3 mm, glabrous, anthers 0.7–1 mm long. *Ovary* glabrous, style up to 1.5 mm long. *Fruits* not seen.

Distribution — One specimen seen from Mt Pulog, Luzon, Philippines.

Habitat — The specimen comes from a "partly open field, close to stream", 2000 m altitude.

Note — *Celestinó c.s.* PNH 4337 is the first and up till now the only collection of a Malesian *Prunus* belonging to the subgenus *Padus* which is characterized by the leaves on the basis of the raceme. It was collected in 1948 on a well-visited mountain and it can be doubted whether it came from a wild tree. Identification is difficult since too many badly demarcated species have been described in this subgenus. Also because of the absence of fruits it seems better to keep it under the Insufficiently known species than to create another synonym which later will have to be reduced.

Prunus D

Tall trees. *Twigs* hairy. *Leaves* elliptic to ovate-oblong, 11–16 by 4.5–7.5 cm, base acute, apex gradually narrowing, coriaceous, with 7–9 pairs of nerves, venation inconspicuous, glabrous above, sparsely hairy below, basal glands 2, flat, at the very base of the midrib. *Petiole* c. 1 cm long.

Stipules not seen. *Racemes* solitary, only seen in fruit, on old twigs, 1–2.5 cm long, stout, peduncle almost absent, rachis hairy, fruiting pedicels up to 2 mm long. *Flowers* only seen as remnants. *Hypanthium* c. 2 mm high, densely hairy outside. *Perianth segments* subequal, 10–12, 2–2.5 mm long, hairy. *Stamens* short, filaments up to 2 mm, anthers 0.6 mm long. *Fruits* compressed (broadly) ovoid, 16–18 by 14–18 mm, exocarp sparsely hairy, especially at top, green when ripe (?), mesocarp thin, endocarp thin (c. 0.5 mm), sparsely hairy inside. *Seed* with glabrous testa.

Distribution — One specimen seen (*Hoogland & Craven 11086*), from E Sepik Province, Papua New Guinea.

Habitat — Rain forest, at 1160 m altitude.

Note — This species belongs to sect. *Mesopygeum* and seems to be rather well distinct. The

fruits are not like any described species, much too large for *Prunus grisea*, too small for *P. turneriana*, two species which could be considered.

EXCLUDED

Prunus zippeliana Miq., Fl. Ind. Bat. I, 1 (1855) 367. — Type: *Zippel s.n.*, Java, holo in L, sheet 908.202-880.

Obviously collected from a cultivated tree, probably in the Botanic Garden at Buitenzorg (Bogor) and originating from Japan. The natural range of the species is China, Taiwan, Japan, and Vietnam.

Several *Pygeum* species names cannot be accounted for, types being lost or insufficient. See lists of 'Incompletely known species' and 'Dubious species' in Kalkman (1965).

AMARYLLIDACEAE

(including Hypoxidaceae)

(D. J. L. Geerinck, Brussels, Belgium)

Perennial herbs with bulbs, tubers or rhizomes. *Leaves* simple, with parallel nerves. *In-florescences* terminal or axillary, in cymes, spikes or umbels (in *Amaryllidoideae*), or flowers solitary, bracteate and often with one or few spathes (in *Amaryllidoideae*). *Flowers* bisexual, actinomorphic or zygomorphic, sometimes marcescent. Tepals in 2 whorls, free or united into a tube, sometimes with a conspicuous corona. Stamens 6, free or sometimes united into a false corona, often inserted at the mouth of the perigone-tube; anthers basifixed, dorsifixed or medifixed, often versatile. Ovary inferior, 3-celled with axillary placentas; ovules 1 to numerous per cell. *Fruit* capsular, dehiscing either loculicidally or irregularly, or fruit a berry. *Seeds* globose or flattened, sometimes winged.

Distribution — Cosmopolitan, with c. 80 genera and around 1000 species. In *Malesia* only 6 genera are indigenous or naturalized, but many others are cultivated in botanic and private gardens (see the list on p. 371).

Taxonomy — The family is treated here in a broad sense, comprising the genera with an inferior ovary, i.e. excluding the *Allioideae* (= *Alliaceae*), which are characterized by a superior ovary. In *Malesia* there are no indigenous species of the latter family, which is treated elsewhere in this instalment (p. 375).

The *Agavoideae* (partly with an inferior ovary and partly with a superior one) are also excluded. The family *Agavaceae* has one indigenous genus in *Malesia* (*Dracaena*, including *Pleomele*).

In the *Amaryllidaceae* two subfamilies are here recognized which are often considered to be distinct families: the *Amaryllidoideae* (= *Amaryllidaceae* s.str.), with umbellate inflorescences and spathes, and the *Hypoxidoideae* (= *Hypoxidaceae*) which are never umbellate and are without spathes.

Haemodoraceae were treated by Van Steenis in *Flora Malesiana* I, 5 (1955) 111–113 [and see Additions in *Fl. Males.* I, 10 (1989) 717].

Palynology — Pollen of *Amaryllidaceae* has been studied in detail by Radulescu (1972), Schulze (1983), Meerow (1987, 1989), and Meerow & Dehgan (1988). *Amaryllidaceae* pollen grains are small to very large (largest equatorial axis 14–158 μm). Small grains (usually < 30 μm) are found in the *Galeoideae* (*Galanthus*, *Leucojum* p.p.). Very large pollen (> 100 μm) occurs only in *Hymenocallis* p.p. Tetragonal tetrads are known in *Stenomesson elwesii* (Meerow et al. 1986).

The apertural system is monosulcate or dicolpate. Sulci are nearly as long as the longest equatorial axis, or extend slightly on the proximal grain side. The position of the colpi in dicolpate pollen with respect to the distal and proximal poles is unknown.

Exine stratification is generally distinct. Electron micrographs show a columellate, tectate or semitectate sexine in monosulcate pollen. Zavada (1983) has demonstrated a very thin, finely granular infratectum and a thick nexine traversed by minute channels in the dicolpate pollen of *Crinum americanum* (*Amaryllidaceae*). An intectate, gemmate sexine was found in the tetrads of *Stenomesson elwesii*.

Ornamentation is reticulate or sparsely scabrate-microechinate, rarely psilate/punctate (*Galantheae*) to verrucate/fossulate (*Eucrosia*). The lumina in reticulate patterns are small to very large (up to c. 10 μm in *Hymenocallis*). Usually lumen size decreases towards the aperture, and often it is distinctly less at the apocolpial ends of a grain. In several *Hymenocallis* species these parts ('auriculae') have an ornamentation quite different and clearly separated from that of the main part of the grain (Ravikumar & Nair 1982; Meerow & Dehgan 1985).

Two main pollen types may be distinguished in the family: 1) monosulcate reticulate pollen, and 2) dicolpate scabrate-microechinate pollen. Infratectum structure might be another important feature separating both types (see above). The latter characterizes all genera of the *Amaryllideae* (sensu Dahlgren et al. 1985; see also Schulze 1983 and Snijman 1991), and *Pauridia* of the *Hypoxidoideae* (Thompson 1979; Simpson 1983). The former type is found in all other *Amaryllidaceae*. The two colpi in *Amaryllideae* pollen are on opposite grain sides, whereas in *Pauridia* pollen they are situated in the same hemisphere. Also the nature of the scabrate ornamentation is different in *Pauridia*. Other *Hypoxidoideae* have monosulcate, finely reticulate pollen, more or less the same as in most *Amaryllidoideae* and many other monocots.

References: Dahlgren, R.M.T., H.T. Clifford & P.F. Yeo, The families of the Monocotyledons (1985) 199. — Meerow, A.W., Syst. Bot. 12 (1987) 460–492; Ann. Missouri Bot. Gard. 76 (1989) 136–220. — Meerow, A.W. & B. Dehgan, Amer. J. Bot. (1985) 540–547; Amer. J. Bot. 75 (1988) 1857–1870. — Meerow, A.W., N.B. Dehgan & B. Dehgan, Amer. J. Bot. 73 (1986) 1642–1644. — Radulescu, D., Acta Bot. Hort. Bucur. 1970–71 (1972) 245–273. — Ravikumar, C. & P.K.K. Nair, J. Palynol. 18 (1982) 43–54. — Schulze, W., Wiss. Z. Fr.-Schiller-Univ. Jena, Math.-Naturwiss. R. 32 (1983) 985–1003. — Simpson, M.G., Grana 22 (1983) 79–103. — Snijman, D.A., Bothalia 21 (1991) 125–128. — Thompson, M.F., Bothalia 12 (1979) 621–625. — Zavada, M.S., Bot. Review 49 (1983) 331–379.

R.W.J.M. van der Ham

Phytochemistry — Difficulties in demarcating families in *Liliales* are aptly discussed by Cronquist (1981, 1988). He accepted *Iridaceae*, *Haemodoraceae*, *Alo(e)aceae*, *Agavaceae*, *Xanthorrhoeaceae* and *Smilacaceae* as distinct families, but united *Amaryllidaceae* s. str. and all modern segregates from *Liliaceae* and *Amaryllidaceae* sensu Pax et Hoffmann (e.g. *Agapanthaceae*, *Alliaceae*, *Alstroemeriaceae*, *Asparagaceae*, *Asteliaceae*, *Anthericaceae*, *Aphyllanthaceae*, *Calochortaceae*, *Colchicaceae*, *Convallariaceae*, *Dianellaceae*, *Hemerocallidaceae*, *Hyacinthaceae*, *Hypoxidaceae*, *Herreriaceae*, *Melianthiaceae*, *Ruscaceae*, *Tecophilaeaceae*, *Tricyrtidaceae*, *Trilliaceae* and others) in *Liliaceae* sensu Cronquist, because there seem to be no characters available for an unequivocal demarcation of such smaller families. In some instances phytochemistry may be able to assist taxonomists in delimitating taxa of subfamily or family rank. This seems exactly to be the case with *Alliaceae*, *Amaryllidaceae* s. str., *Hypoxidaceae* and *Haemodoraceae* [the latter already

treated in Flora Malesiana I, 5 (1954) 111–115, but without a paragraph on phytochemistry]. Therefore the taxonomically most promising secondary metabolites of the four taxa mentioned will be discussed shortly sub *Alliaceae* and *Amaryllidaceae*. The chemistry and chemotaxonomy of all four taxa was treated more comprehensively by Hegnauer (1963, 1986). Chelidonic acid seems to be a major organic acid in all of them and in most *Lilia-ceae* sensu Cronquist.

Amaryllidaceae s. str. (= *Amaryllidoideae* sensu Melchior 1964). — *Alkaloid* production and storage is a key character of this taxon (Hegnauer 1990). Amaryllidaceous or lycorine-type alkaloids seem to be present in every species of *Amaryllidoideae* and have never been found outside this taxon. Lycorine-type alkaloids represent a biosynthetically distinct type of alkaloids. They originate by condensation of a hydroxybenzaldehyde (C_6-C_1 -moiety) derived from phenylalanine with tyramine (C_6-C_2 -moiety) derived from tyrosine. The resulting dicyclic belladine-type bases are intermediates on the way to the more numerous tri- and tetracyclic amaryllidaceous alkaloids. These alkaloids are toxic and are stored often in combined forms such as glycosides, as glycosides acylated by fatty acids and as phospholipids (Ghosal et al. 1985, 1991). Moreover, oxidation to quaternary compounds (e.g. anhydrolycorinium, ungeremine) which may be subsequently transformed to Schiff bases [$R_1, R_2 = C = N-R_3$ like crinasiatine (Ghosal et al. 1988)] occurs under certain conditions. Ghosal et al. (1990, 1991) described an astonishingly perfect co-evolution between the specialised moth *Polytela gloriosa* and its host plants *Amaryllis belladonna* and *vittata* (= *Hippeastrum vittatum*), *Crinum asiaticum* and *latifolium* and *Pancratium biflorum*. The moth makes use of toxic amaryllidaceous alkaloids for defensive purposes and transforms ingested bases for storage in its own glycosides and acylated glycosides, and the plant responds to the stress of herbivory by releasing free, more toxic alkaloids from stored combined forms in young fruits. Moreover, both the moth and several of its host plants respond to certain stress conditions with synthesis of one and the same alkaloidal conjugate termed telastaside (Ghosal et al. 1991). Kumar & Roy (1985) recorded a strong allelopathic effect for lycorine; this alkaloid inhibits germination of fern spores and kills prothallia.

Phenolic compounds are represented by several classes. Caffeic acid and glycosides of the flavonols kaempferol and quercetin seem to be nearly ubiquitous. Acetophenone derivatives were isolated from species of *Buphane* (acetovanillone), *Lycoris* (trimethyl ether of phloracetophenone) and from *Pancratium biflorum* [several derivatives of phloracetophenone (Ghosal et al. 1989)]. Oddly substituted flavans, flavan-3-ols, chalcones and 2-methylchromones were reported for *Hippeastrum ananuca*, *Narcissus pseudonarcissus* and isolated from bulbs and flowering stalks of *Pancratium biflorum* (Ghosal et al. 1989). Chromones and flavans were reported also for bulbs of *Pancratium maritimum* (Ali et al. 1990) and flavans and chalcones are present in bulbs of *Crinum augustum* (Abd El-Hafiz et al. 1990). Obviously these phenolic compounds are phytoalexins in some instances (*Narcissus pseudonarcissus*). A strange type of parasitism was described by Ghosal et al. (1986). Stolons of the grass *Imperata cylindrica* penetrate bulbs of *Pancratium biflorum*, cause cell necrosis and initiate synthesis of red coloured stress compounds (flavans, chalcones) and release of cytotoxic free alkaloids from their conjugates. Piscidic acid is known from *Narcissus poeticus*, and *Lycoris radiata* yielded a deoxypiscidic acid. These two aro-

matic acids may be connected with tyrosine metabolism and may have *p*-hydroxyphenylpyruvic acid and acetic acid or an equivalent C₂ compound as building stones.

Saponins seem to be totally lacking in true *Amaryllidaceae*.

Amaryllidaceae store starch in vegetative storage organs. In many taxa starch is accompanied by water-soluble carbohydrates, fructans or glucomannans. The latter may become the main carbohydrate reserve in a number of taxa. A tendency to replace starch by water-soluble carbohydrates in vegetative storage organs of perennial plants is perceptible in many other more or less cosmopolitan families of monocotyledons, e.g. *Agavaceae*, *Gramineae*, *Iridaceae*, *Liliaceae* s.l.

Hypoxidaceae (*Hypoxidoideae*) — Glycosidic 1,5- and 1,3-diarylpentanes seem to be key metabolites of *Hypoxidaceae*, which comprise many species of importance to traditional medicine in Africa and Asia including China and Japan. Rooperol, an 1,5-diarylpenta-1-en-4-yn with four phenolic hydroxyls is the aglycone of hypoxoside and the obtusosides of *Hypoxis nyasica*, *obtusata*, *rooperi* and others. Nyasol, 1,3-diaryl-1,4-pentadien with two phenolic hydroxyls is the aglycone of several glycosides from *H. angustifolia* (Sibanda et al. 1990) and nyasicol, a 1,5-diaryl-1,2-dihydroxypenta-4-yn with four phenolic OH's, is the aglycone of several glycosides of *H. nyasica* (Galeffi et al. 1987), *H. angustifolia*, *interjecta* and *multiceps* (Sibanda et al. 1990; Marini-Bettolo et al. 1991). Nyasicoside was also isolated from rhizomes of an African species cited as *Curculigo recurvata* (Chifundera et al. 1991). Biosynthetically these C₆-C₅-C₆ phenolic aglyca are probably related to lignans which arise by condensation of two phenylpropane (C₆-C₃) building stones and have a C₆-C₃ + C₃-C₆ skeleton. Because one C-atom is lost, such C₆-C₅-C₆ compounds are also termed norlignans, norneolignans or even nonlignans or conioids; they were formerly studied intensively in conifers (see Hegnauer 1986: 479, 481, 496).

Acuminatoside from rhizomes of *Hypoxis acuminata* (Bredenkamp et al. 1989) and whole plants of *H. obtusata* (Msonthi et al. 1990) is the apiosylglucoside of geraniol.

Flavonoids are represented in the family by glycosides of kaempferol and quercetin. Rhizomes and tuberous roots of *Curculigo orchoides* yielded a derivative of 2,3-dihydromyricetin.

Simple phenolic glycosides seem to be rather common in *Hypoxidoideae*. From whole plants of *H. obtusata* Msonthi et al. (1990) isolated also obtusaside, a glucoside of gentisyl alcohol which has OH-6 of its glucose esterified by 2,6-dimethoxy-3-hydroxybenzoic acid. Rhizomes of *C. orchoides* contain curculigoside, which is 2',6'-dimethoxysalireposide, and corchioside-A, which is a xyloglucoside of orcinol (Garg et al. 1989).

Curculigo orchoides is a famous medicinal plant from India and China known in Ayurvedic medicine as 'Kali Musli' (Pandey et al. 1983) and in China as 'Xiao Mao' (Jun-Ping Xu et al. 1992). The lipid fraction of this crude drug (rhizomes + roots) yielded interesting alkanones, the cycloartane derivative curculigol (Misra et al. 1990), a new pentacyclic triterpene (Mehta & Gawarikar 1991) and several phytosterols. Yun-Ping Xu et al. (1992) isolated a saponin mixture containing curculigosaponins-A to -J, all with the same sapogenin, curculigenin, which is a cycloartane derivative. Obviously in contrast to many *Liliaceae* s.l. (see e.g. sub *Alliaceae*), *Dioscoreaceae* and other families of monocotyledons, *Hypoxidoideae* do not produce steroidal C₂₇-sapogenins, but triterpenic sapogenins with the tetracyclic skeleton of cycloartane.

Haemodoraceae — Yellow to red 9-phenylphenalenones and biogenetically related pigments are chemical markers of true *Haemodoraceae*. They are deposited in subterranean parts, leaf bases, flowers, fruits and seeds and occur free (e.g. haemodorrin) and as glycosides (e.g. haemocorrin). Phenalenone pigments were isolated from species of *Anigozanthos*, *Conostylis*, *Haemodorrin*, *Lachnanthes*, *Macropidia*, *Phlebocarya*, *Wachendorfia* and *Xiphidium*. Quite recently a new phenalenone pigment, thyrsiflorin, was isolated from the yellow flowers of *Wachendorfia thyrsiflora*, which contains two other phenalenones in its roots (Dora et al. 1990). Obviously the North American genus *Lophiolla* does not belong to *Haemodoraceae*; its two species do not produce phenalenone pigments. Phenalenones also occur in some Fungi; fungal phenalenones have a polyketide origin, whereas *Haemodoraceae* produce their pigments from one phenylalanine, one tyrosine and one acetate.

References: Abd El-Hafiz, M.A., et al., J. Nat. Prod. 53 (1990) 1349. — Ali, A.A., et al., Phytochemistry 29 (1990) 625. — Bredenkamp, N.W., et al., Phytochemistry 28 (1989) 263. — Chifundera, K., et al., Tetrahedron 47 (1991) 4369. — Cronquist, A., An integrated system of classification of flowering plants, Columbia Univ. Press (1981); The evolution and classification of flowering plants, 2nd ed., New York Bot. Garden (1988). — Dora, G., et al., Planta Medica 56 (1990) 569. — Galeffi, C., et al., Tetrahedron 43 (1987) 3519. — Garg, S.N., et al., Phytochemistry 28 (1989) 1771 (also alkanols, phyto-sterols, cycloartenol). — Ghosal, S., et al., Phytochemistry 24 (1985) 1825 (glucoalkaloid kalbreclasin), 2141 (chemistry and biology of *Crinum* alkaloids: review), 2703 (acyloxy alkaloid palmilycorine and acylglucosyloxy alkaloid lycoriside from *Crinum asiaticum*); ibid. 25 (1986) 1097; ibid. 27 (1988) 1849 (new types of alkaloids, e.g. craugsodine, isocraugsodine, crinasiatine from fruits of *Crinum asiaticum*); ibid. 28 (1989) 3193; ibid. 29 (1990) 805; Indian J. Chem. 30B (1991) 260 (telastaside). — Hegnauer, R., Chemotaxonomie der Pflanzen 2 (1963); 7 (1986): *Alliaceae* 281, 315–325, 488–489, 501, 685–731, 803; *Amaryllidaceae* s.str. 53–70, 475, 573–580; *Haemodoraceae* 228–230, 657–660; *Hypoxidaceae* 234–236, 661–663. — Hegnauer, R., in P. Baas, R. Geesink & C. Kalkman, The plant diversity of Malesia, Kluwer Acad. Publ., Dordrecht (1990) 97. — Kumar, G. & S.K. Roy, Indian J. Exp. Biol. 23 (1985) 356. — Marini-Bettolo, G.B., et al., Tetrahedron 47 (1991) 6717. — Mehta, B.K. & R. Gawarikar, Indian J. Chem. 30B (1991) 986. — Melchior, H. in Engler, Syll. Pflanzenfam. 2 (1964) 528. — Misra, T.N., et al., Phytochemistry 29 (1990) 929. — Msonthi, J.D., et al., Phytochemistry 29 (1990) 3977. — Pandey, H.C., et al., Intern. J. Crude Drug Res. 21 (1983) 33. — Sibanda, S., et al., Biochem. Syst. Ecol. 18 (1990) 481. — Xu, Jun-Ping, et al., Phytochemistry 31 (1992) 233; Planta Medica 58 (1992) 208.

R. Hegnauer

KEY TO THE GENERA

(Genera of cultivated species included)

- 1a. Inflorescence always an umbel with 1 to few spathes (*Amaryllidoideae*) 2
- b. Inflorescence not an umbel, spathes absent (*Hypoxidoideae*) 18
- 2a. Filaments inserted on the throat of the perigone-tube, with a thin membrane some-
times 1- or 2-toothed between the filaments (false corona). True corona absent . . . 3
- b. Filaments free from the perigone-tube, false corona absent. True corona present or
not 6
- 3a. Leaves distinctly petiolate, subcircular to elliptic, cuneate to slightly cordate at base . 4
- b. Leaves sessile or subpetiolate, linear to narrowly elliptic, attenuate into the petiole 5

- 4a. Perigone-tube up to 3.5 cm long, straight. Ovules 2 per cell . . . **Proiphys** (p. 363)
 b. Perigone-tube at least 3.5 cm long, often curved. Ovules usually 6 or more per cell
 Eucharis (cult., p. 371)
- 5a. Ovary with 10 or more biseriate ovules in each cell. Fruit dry, 3-loculicid. Seeds black **Pancratium** (p. 362)
 b. Ovary with 1–9 ovules near the bottom in each cell. Fruit fleshy, finally rupturing laterally. Seeds green **Hymenocallis** (p. 361)
- 6a. Flowers with a corona **Narcissus** (cult., p. 373)
 b. Flowers without a corona 7
- 7a. Inflorescences always 1-flowered 8
 b. Inflorescences 2- to many-flowered 10
- 8a. Perigone zygomorphic with free tepals; the outer ones much broader than the inner, the latter connate into a channel enveloping stamens and style
 Sprekelia (cult., p. 373)
 b. Perigone actinomorphic with tepals united at the base 9
- 9a. Perigone-tube less than 3 cm long. Longest filaments more than 10 cm long. Style bent out of the flower **Zephyranthes** (cult., p. 373)
 b. Perigone-tube more than 5 cm long. Longest filaments less than 8 cm long. Style erect in the centre of the flower **Cooperia** (cult., p. 371)
- 10a. Tepals free, brilliant white with a small green blotch below the top
 Leucojum (cult., p. 372)
 b. Tepals at base united into a tube 11
- 11a. Flowers distinctly zygomorphic. 12
 b. Flowers actinomorphic or nearly so 14
- 12a. Leaves petiolate, 2 or 3 times as long as wide. Perigone violet. Ovules 2 per cell
 Griffinia (cult., p. 372)
 b. Leaves sessile, more than 5 times as long as wide. Perigone red, reddish, pink or white. Ovules numerous in each cell 13
- 13a. Peduncle solid **Amaryllis** (cult., p. 371)
 b. Peduncle fistular **Hippeastrum** (cult., p. 372)
- 14a. Perigone-tube more than 5 cm long **Crinum** (p. 359)
 b. Perigone-tube up to 5 cm long 15
- 15a. Peduncle fistular. Stamens inserted in the perigone-tube. Fruit a capsule 16
 b. Peduncle solid. Stamens inserted at the throat or on the segments of the perigone. Fruit a berry. 17
- 16a. Perigone-tube funnel-shaped **Cyrtanthus** (cult., p. 371)
 b. Perigone-tube narrow **Vallota** (cult., p. 373)
- 17a. Perigone-tube funnel-shaped, segments wide, orange-coloured
 Clivia (cult., p. 371)
 b. Perigone-tube narrow, segments linear, reddish to purple **Scadoxus** (cult., p. 373)
- 18a. Tepals very shortly to distinctly united into a tube. Fruit fleshy, indehiscent or irregularly dehiscent, often persistently beaked **Curculigo** (p. 366)
 b. Tepals free. Fruit dry, regularly dehiscent, never beaked **Hypoxis** (p. 370)

Subfamily Amaryllidoideae

Inflorescence umbellate, or flowers solitary, and always with one or few spathes. *Flowers* actinomorphic or zygomorphic. Tepals free or united into a tube, sometimes with a conspicuous corona. Stamens free or sometimes united into a false corona.

The majority of the genera and species belong to this subfamily.

CRINUM

Crinum L., Sp. Pl. (1753) 290. — Type species: *Crinum americanum* L.

Bulbous herbs. *Leaves* radical, rarely biseriate, sessile or subpetiolate. *Inflorescences* umbellate, many- to 1-flowered, with 2 spathes; scape lateral, solid. *Flowers* white or pinkish, sometimes with a red keel. Tepals subequal, united at the base into a long and narrow tube. Stamens inserted in the throat; filaments free; anthers dorsifixed. Ovary with 1 to many ovules per cell; style filiform; stigma entire. *Fruits* indehiscent or irregularly dehiscent, with a fleshy or membranous wall. *Seeds* globose or somewhat flattened, greenish or greyish. — **Fig. 1.**

Distribution — About 100 species in the tropics; 2 indigenous species in *Malesia*. Other species are cultivated in gardens and may escape sometimes.

KEY TO THE SPECIES

1a. Leaves narrowly to broadly elliptic, wider than 3.5 cm. Anthers 12–35 mm long

1. *C. asiaticum*

b. Leaves oblong to narrowly elliptic, to 3.5 cm wide. Anthers 7–9 mm long

2. *C. gracile*

1. *Crinum asiaticum* L., Sp. Pl. (1753) 292; Ker-Gawl., Curt. Bot. Mag. 27 (1808) t. 1073; Miq., Fl. Ned. Indië 3 (1859) 580; Blanco, Fl. Filip. ed. 3, 1 (1877) 314, t. 168; Naves, Nov. App. (1880) 254; Baker, Handb. Amaryll. (1888) 75; Koord., Meded. Lands Plantent. 19 (1898) 309; Ridley, Mat. Fl. Mal. Penins. 2 (1907) 68; Hallier, Nova Guinea 8 (1913) 899; Laut., Bot. Jahrb. 50 (1913) 302; Ridley, Fl. Mal. Penins. 4 (1924) 301; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 210; Henderson, Mal. Wild Fl. (1954) 164; Backer & Bakh. f., Fl. Java 3 (1968) 136 (s.l.). — Types: India, Malabar Coast and Sri Lanka in LINN.

Crinum amabile Donn, Hort. Cantabr. ed. 6 (1811) 83; Ker-Gawl., Curt. Bot. Mag. 39 (1814) t. 1605; Miq., Fl. Ned. Indië 3 (1859) 580; Naves, Nov. App. (1880) 254; Baker, Handb. Amaryll. (1888) 75. — Type: *Hort. Kew*, Sumatra.

Crinum sumatranum Roxb., Hort. Beng. (1814) 23; Miq., Fl. Ned. Indië 3 (1859) 581; Lindley, Edw. Bot. Reg. 13 (1887) t. 1049; Naves, Nov. App. (1880) 254; Baker, Handb. Amaryll. (1888) 75. — Type: *Campbell*, Sumatra.

Crinum macrantherum Engler, Bot. Jahrb. 7 (1886) 448; Peekel, Fl. Bismarck Arch. Natur. (1984) 87. — Type: *Naumann* 75, Bismarck Archipelago.

Crinum northianum Baker, Gard. Chron. 1 (1882) 671; Handb. Amaryll. (1888) 82; Ridley, Agr. Bull. 3 (1904) 310; Fl. Mal. Penins. 4 (1924) 301. — Type: *North* 424, Borneo, Sarawak.

Crinum cortifolium Hallier, Nova Guinea 8 (1913) 900. — Type: *von Römer* 189, New Guinea.

Crinum macrophyllum Hallier, Nova Guinea 8 (1913) 899. — Type: *Versteeg* 1219, New Guinea.



Fig. 1. *Crinum asiaticum* L. Habit of flowering plant. New Guinea, bank of Merau R., NE of Merauke, Irian Jaya (Photograph P. van Royen, 1954).

Crinum rumphii Merr., Interpr. Rumph. Herb. Amboin. (1917) 141. — Type: *Robinson Pl. Rumph. Amb. 131*, Ambon.

Haemanthus pubescens auct. non L. f.: Blanco, Fl. Filip. (1837) 253.

Crinum giganteum auct. non Andr.: Blanco, Fl. Filip., ed. 2 (1845) 175.

Crinum defixum auct. non Ker-Gawl.: Ridley, Mat. Fl. Mal. Penins. 2 (1907) 68; Fl. Mal. Penins. 4 (1924) 301.

Herb to 200 cm tall. *Leaves* narrowly to broadly elliptic, 50–150 by (3–)3.5–20 cm. *Umbels* 10–50-flowered; peduncle 3.5–12.5 cm long; spathes 9–16 cm long; pedicels 1–5 cm. *Flowers* white, fragrant at night. Perigone-tube 7.5–13 cm; lobes 6–12.5 by 4–12 mm. Stamens pink to pur-

ple; filaments 3.5–7 cm long; anthers straight, 12–35 mm long. *Seeds* 1–5 per cell. — **Fig. 1.**

Distribution — Continental Asia (India, Burma, Thailand, Laos, Cambodia, Vietnam), Cocos Is. (Indian Ocean), Mascarenes, NW Australia, Pacific Is. (Guam, Carolines, Marshalls, Solomons, New Caledonia, Fiji, Samoa); *Malesia*: Sumatra, Malaya, Singapore, Borneo (Brunei, Sarawak), Java, Madura, Philippines (Luzon, Mindoro, Palawan, Mindanao), N Celebes, Timor, Moluccas (Ambon, Seram), New Guinea (Merauke, Sepik, Milne Bay), Bismarck Archipelago.

Habitat — Sandy places, also coastal; riverine forests.

Uses — Leaves and bulbs have medicinal uses as emetic, etc. in India (Quisumbing, Medic. Pl. Philipp. 1951, 171).

2. *Crinum gracile* E. Meyer in Presl, Rel. Haenk. 1 (1827) 120; Naves, Nov. App. (1880) 255; Baker, Handb. Amaryll. (1888) 81; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 210. — Type: *Haenke*, Luzon.

Crinum cumingii Baker, Gard. Chron. 2 (1881) 72; Handb. Amaryll. (1888) 81; Vidal, Phan. Cuming. Philipp. (1885) 152; Rev. Pl. Vasc. Filip. (1886) 275. — Type: *Cuming* 1382, Luzon.

Herb to 80 cm tall. *Leaves* oblong to narrowly elliptic, 30–60 by 1–3.5 cm. *Umbels* 5–12-flowered; peduncle 15–30 cm long; spathes 5–7 cm long; pedicels 0.5–2 cm long. *Flowers* white. Perigone-tube 5–12 cm long; lobes 5–8 by 5–10 mm. Stamens purple; filaments 5–7 cm long; anthers slightly curved, 7–9 mm long. Style purple. *Seeds* unknown.

Distribution — *Malesia*: Sumatra (Palembang), Philippines (Luzon, Mindoro, Mindanao), New Guinea.

Habitat — Primary and savanna forests at low altitudes.

CULTIVATED SPECIES

Crinum fimbriatum Baker — Backer & Bakh.f., Fl. Java 3 (1968) 137.

Native to tropical Africa; cultivated as an ornamental. Umbel 3–8-flowered; perigone whitish to purplish.

Crinum jagus (Thomps.) Dandy — *Crinum giganteum* Andr.; Backer & Bakh.f., Fl. Java 3 (1968) 137.

Native to tropical Africa; cultivated as an ornamental. Umbel 2–12-flowered; flowers fragrant; perigone white.

Crinum kirkii Baker — Backer & Bakh.f., Fl. Java 3 (1968) 137.

Native to tropical Africa; cultivated as an ornamental. Umbel 12–20-flowered; perigone greenish.

Crinum latifolium L. — Merr., Enum. Philipp. Flow. Pl. 1 (1925) 210; Steiner, Philipp. Ornam. Pl. (1960) 137; Peekel, Fl. Bismarck Arch. Natur. (1984) 87. — *Crinum moluccanum* Roxb.; Miq., Fl. Ned. Indië 3 (1859) 581.

Native to tropical Asia; cultivated as an ornamental and perhaps escaped. Umbel 10–20-flowered; flowers fragrant; perigone green tinged with red.

Crinum longiflorum Thunb. — Backer & Bakh.f., Fl. Java 3 (1968) 136.

Native to South Africa; cultivated as an ornamental. Umbel 6–16-flowered; flowers fragrant; perigone greenish.

Crinum moorei Hook. f. — Backer & Bakh.f., Fl. Java 3 (1968) 136.

Native to South Africa; cultivated as an ornamental. Umbel 6–12-flowered; perigone pinkish.

Crinum* × *powellii Baker — Backer & Bakh.f., Fl. Java 3 (1968) 136.

Hybrid between the two preceding species; cultivated as an ornamental.

Crinum pusillum auct. non Herbert? — Miq., Fl. Ned. Indië 3 (1859) 581.

Doubtful species.

Crinum sanderianum Baker — Backer & Bakh.f., Fl. Java 3 (1968) 136.

Native to tropical Africa; cultivated as an ornamental. Umbel 3–6-flowered; perigone white with a pink top.

Crinum zeylanicum L. — Merr., Enum. Philipp. Flow. Pl. 1 (1925) 211; Backer & Bakh.f., Fl. Java 3 (1968) 137.

Native to tropical Africa and Asia; cultivated as an ornamental and subnaturalized. Umbel 6–25-flowered; flowers fragrant; perigone white with wide pink bands.

HYMENOCALLIS

Hymenocallis Salisb., Trans. Hort. Soc. Lond. 1 (1812) 338. — Type species: *Hymenocallis littoralis* (Jacq.) Salisb.

Bulbous herbs. *Leaves* radical, sessile or subpetiolate. *Inflorescences* umbellate, many- to 2-flowered, with 2 spathes. *Flowers* white. Tepals equal, united into a long tube; segments erect to patent. Stamens inserted in the throat, basally connected by a thin membrane (false corona) which is entire to deeply incised between the filaments. Ovary with 1–9

ovules near the bottom of each cell; style filiform; stigma entire and small. *Fruits* fleshy, finally rupturing laterally. *Seeds* spongy, green.

Distribution — About 50 species in tropical and subtropical America, a few cultivated; in *Malesia* there is one naturalized species.

Hymenocallis littoralis (Jacq.) Salisb., Trans. Hort. Soc. Lond. 1 (1812) 338; Merr., Sp. Blanc. (1918) 98; Enum. Philipp. Flow. Pl. 1 (1923) 211; Backer & Bakh. f., Fl. Java 3 (1968) 138; Peekel, Fl. Bismarck Arch. Natur. (1984) 89. — *Pancratium littorale* Jacq., Select. Stirp. Amer. Hist. (1763) 99; Ker-Gawl., Curt. Bot. Mag. 21 (1805) t. 805; Safford, Contr. U.S. Nat. Herb. 9 (1905) 342. — Type: *Jacquin*, West Indies.

Hymenocallis adnata Herbert, Amaryll. Suppl. (1837) 215, nom. illeg.; Naves, Nov. App. (1880) 256.

Hymenocallis tenuiflora Herbert, Amaryll. Suppl. (1837) 215; Naves, Nov. App. (1880) 149. — Type: *Hilton 143*, New Granada.

Pancratium illyricum auct. non L.: Blanco, Fl. Filip. ed. 3, 1 (1877) 316.

Pancratium maritimum auct. non L.: Blanco, Fl. Filip. ed. 3 (1877) 316; Naves, Nov. App. (1880) 256.

Bulb spherical, 7.5–10 cm in diameter. *Leaves* 2-ranked, stalkless, oblong, 40–120 cm by 1.5–5 (–7) cm, acute. *Inflorescences* 6–11-flowered; peduncle 45–60 cm long; spathes 6–7 cm long; pedicel none to very short. *Flowers* fragrant. Perigonetube 14–17 cm long; segments linear, channelled, 7.5–12 cm long and 2–3 mm wide, tipped. False corona 2.5–3 cm high; free part of filaments c. 6 cm. Ovules 4–5 per cell, style slightly exceeding the stamens.

Distribution — South to Central America; cultivated and naturalized in tropical Africa, tropical Asia, *Malesia* and the Pacific Islands. *Malesia*: Java, Philippines (Luzon), Bismarck Archipelago.

Habitat — Along the seashore and in moist sandy places at low altitudes.

CULTIVATED SPECIES

Hymenocallis caribaea (L.) Herbert — Backer & Bakh. f., Fl. Java 3 (1968) 138.

Native of the West Indies; cultivated as an ornamental. Flowers fragrant; perigone greenish; false corona 2–3 cm long.

Hymenocallis* × *macrostephana Baker — Backer & Bakh. f., Fl. Java 3 (1968) 138.

A hybrid between the two following species; cultivated as an ornamental. Flowers fragrant; perigone white to greenish; false corona 5.5–6 cm long.

Hymenocallis narcissiflora (Jacq.) MacBr. — Backer & Bakh. f., Fl. Java 3 (1968) 138.

Native of South America; cultivated as an ornamental. Flowers fragrant; perigone green and white; false corona 6–7.5 cm long.

Hymenocallis speciosa (Salisb.) Salisb. — Backer & Bakh. f., Fl. Java 3 (1968) 138.

Native of the West Indies; cultivated as an ornamental. Flowers fragrant; perigone greenish and white; false corona 2.5–5 cm long.

PANCRATIUM

Pancratium L., Sp. Pl. (1753) 290. — Type species: *Pancratium maritimum* L.

Bulbous herbs. *Leaves* radical, biseriate, sessile. *Inflorescences* umbellate, few- to 1-flowered, with 1 or 2 spathes. *Flowers* white. Tepals subequal, united at the base into a long and narrow tube. Stamens inserted in the throat, basally connected by a thin membrane (false corona) which is sometimes 1- or 2-toothed between the filaments; anthers dorsifixed. Ovary with 10 or more biseriate ovules filling each cell; style filiform; stigma entire. *Capsules* loculicidal, 3-valved. *Seeds* angular by pressure, black. — **Fig. 2.**

Distribution — About 15 species in S Europe, tropical Africa and Asia, a few cultivated; in *Malesia* one indigenous species and a few others cultivated.

Pancratiun zeylanicum L., Sp. Pl. (1753) 290; Hooker, Curt. Bot. Mag. 52 (1825) t. 2528; Miq., Fl. Ned. Indië 3 (1859) 582; Blanco, Fl. Filip., ed. 3, 1 (1877) 317; Naves, Nov. App. (1880) 256; Baker, Handb. Amaryll. (1888) 48; Koord., Meded. Lands Plantent. 19 (1898) 310;

Merr., Fl. Manila (1912) 148; Sp. Blanc. (1918) 99; Enum. Philipp. Flow. Pl. 1 (1925) 212; Backer & Bakh. f., Fl. Java 3 (1968) 141. — Type: Probably from Sri Lanka, but perhaps of garden origin.

Glabrous herbs. *Leaves* linear to narrowly elliptic, acute, 12–40 cm by 8–30 mm. *Inflorescences* 1-flowered; peduncle 4–15 cm long; spathe 1, 2-nerved, apically bilobed, 4–5 cm long; pedicel absent or very short. *Flowers* with 2.5–3.5 cm long perigone-tube, lobes linear, 6.5–8 cm long and 4–7 mm wide, acuminate. False corona toothed, 3.5–4 cm high; free part of filaments 2.5–4 cm. Style exceeding the stamens. — **Fig. 2.**

Distribution — *Malesia*: Borneo (Pandaran), Java, Philippines (Luzon, Palawan, Biliran), Celebes (Minahasa), Moluccas (Ambon, Gorontala). Also cultivated in gardens.

Habitat — Grasslands, light forest and plantations, up to 600 m altitude.

CULTIVATED SPECIES

Pancratiun longiflorum Roxb. — Miq., Fl. Ned. Indië 3 (1859) 583.
Doubtful species.

Pancratiun maritimum L. — Backer & Bakh. f., Fl. Java 3 (1968) 141.

Native to the Mediterranean region; cultivated as an ornamental. Free part of the filaments 6–10 mm long.

Pancratiun verecundum Ait. — Backer & Bakh. f., Fl. Java 3 (1968) 141.

Native of SE Asia; cultivated as an ornamental. Free part of the filaments 2–3 cm long.

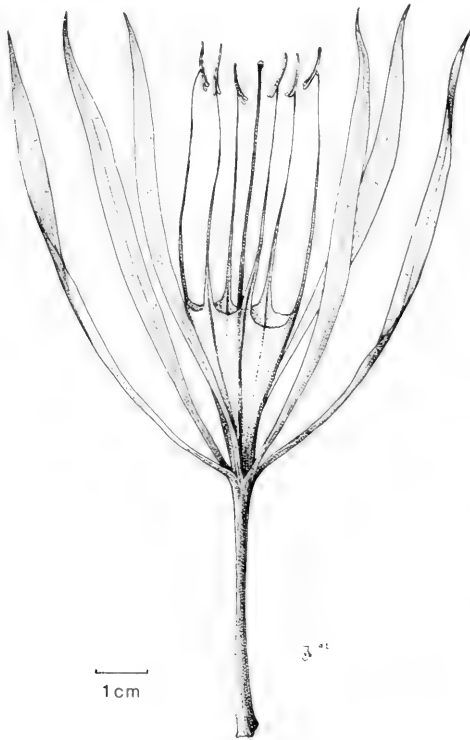


Fig. 2. *Pancratiun zeylanicum* L. Flower without ovary (Korthals s.n., L 897.324-159).

PROIPHYS

Proiphys Herbert, App. (1821) 42; Mabberley, Taxon 29 (1980) 597. — *Eurycles* Salisb. ex Schult. in Roem. & Schult., Syst. Veget. 7/2 (1830) 909, nom. illeg., superfl. — Type species: *Proiphys amboinensis* (L.) Herbert.

Bulbous herbs. *Leaves* radical, petioled, subcircular to elliptic, with numerous parallel nerves. *Inflorescences* umbellate, many-flowered; spathes 2–4. *Flowers* pedicellate, white. Tepals united into a narrow tube; segments subequal, erect to patent, elliptic to obovate, apiculate. Stamens inserted in the throat, basally connected by a membrane (false corona) which is deeply bilobed between the filaments and shorter than the perigone; anthers medifixed. Ovary with 2 ovules in each cell; style filiform; stigma entire, small. *Fruits* dry or slightly fleshy, rupturing irregularly. *Seeds* globose, green. — **Figs. 3, 4.**

Distribution — In Australia 3 species, two of them also indigenous in *Malesia*.



Fig. 3. *Proiophis amboinensis* (L.) Herbert. Cultivated in the Hortus Botanicus Leiden, 1961 (Photograph Rijksherbarium Leiden).

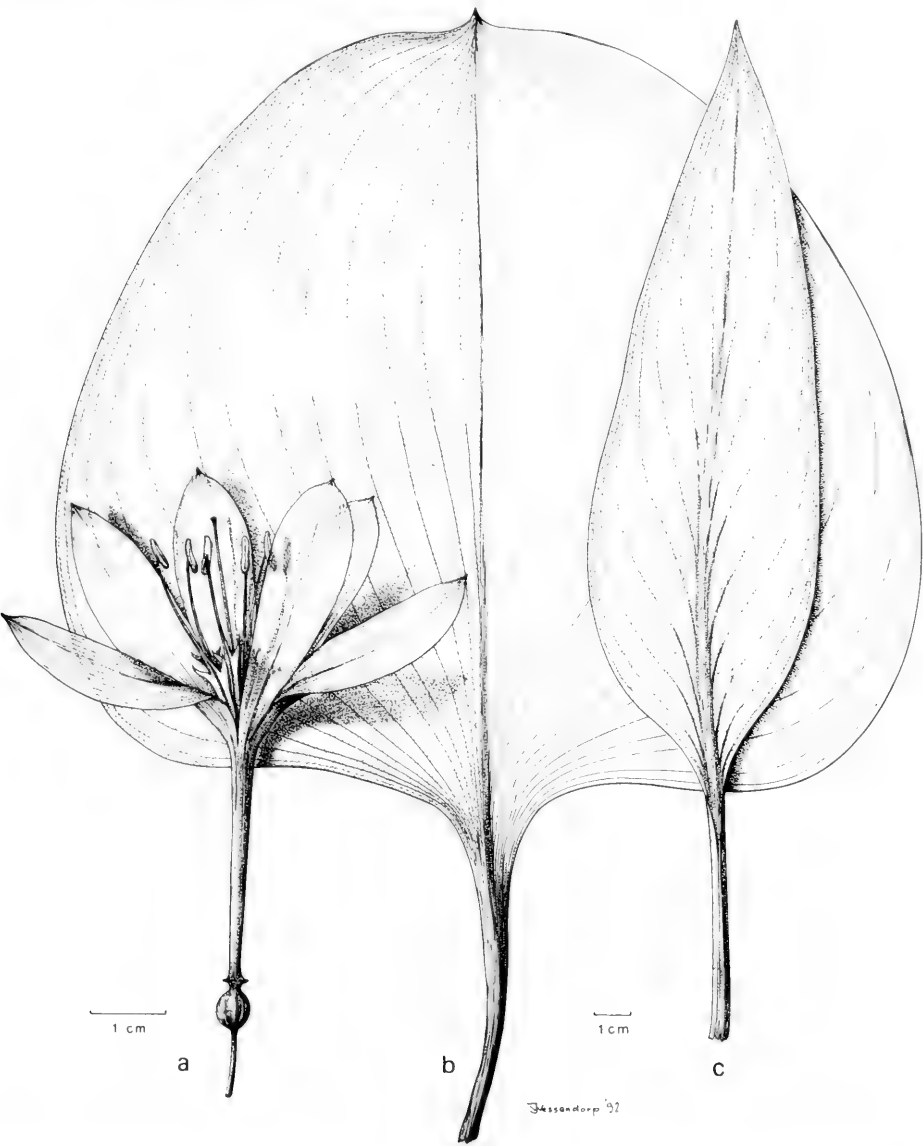


Fig. 4. *Proiphys amboinensis* (L.) Herbert. a. Flower; b. leaf. — *P. alba* (R. Brown) Mabberley. c. Leaf (a, b: de Boer bb 2225; c: McKee 1713).

KEY TO THE SPECIES

- 1a. Leaves elliptic to ovate, less than 15 cm wide, cuneate at base. Spathes 2–3 cm long. Perigone-tube 8–15 mm long; segments less than 25 mm long 1. *P. alba*
- b. Leaves subcircular to broadly ovate, slightly cordate at base, 15 cm or more wide. Spathes 3–10 cm long. Perigone-tube 22–35 mm long; segments 25 mm long or more 2. *P. amboinensis*

1. **Proiophys alba** (R. Brown) Mabblerley, Taxon 29 (1980) 601. — *Eurycles alba* (R. Brown) F. Muell., Sec. Cens. Austral. Pl. (1889) 196. — Type: *R. Brown*, Queensland.

Bulb 2–4 cm diam. *Leaves*: petiole 7–35 cm long; limb elliptic to ovate, cuneate at base, 10–35 cm long and 2–10 cm wide, margin flat. *Umbel* 10–30-flowered; spathes 3 or 4, 2–8 cm long; pedicels 7–30 mm long. *Flowers* with 8–15 mm long perigone-tube, lobes 6–24 mm long. False corona 5–12 mm long; free part of filaments 2–3 mm. *Fruits* unknown. — **Fig. 4c.**

Distribution — Australia; *Malesia*: New Guinea (Merauke). Also cultivated in gardens.

Habitat — Woodlands at low altitudes.

2. **Proiophys amboinensis** (L.) Herbert, Appendix (1821) 42. — *Pancratium amboinense* L., Sp. Pl. (1753) 291; Blanco, Fl. Filip. ed. 3, 1 (1877) 317. — *Eurycles amboinensis* (L.) Lindley in Loud. Encycl. Pl. (1829) 242; Miq., Fl. Ned. Indië 3 (1859) 582; Naves, Nov. App. (1880) 255; Vidal, Phan. Cuming. Philipp. (1885) 152; Rev. Pl. Vasc. Filip. (1886) 276; Koord., Meded. Lands Plantent. 19 (1898) 310; Merr., Fl. Manila (1912) 149; Sp. Blanc. (1918) 99; Hallier, Nova Guinea 8 (1913) 900; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 211; Henderson, Mal. Wild Fl., Monocot. (1954) 166; Backer & Bakh. f., Fl. Java 3 (1968) 140; Peekel,

Fl. Bismarck Arch. Natur. (1984) 89. — Type: Indonesia, illustration in Commelin, Hort. Med. Amstel. Pl. 1 (1697) t. 39, as *Narcissus amboinensis*.

Eurycles sylvestris Salisb. ex Schult., Syst. Veget. 7 (1830) 909, nom. illeg.; Salisb., Trans. Hort. Soc. Lond. ed. 1, 1 (1812) 337, nomen; Ridley, Fl. Mal. Penins. 6 (1924) 303. — Type: Rumph., Herb. Amb. 6, t. 70, as *Caepa sylvestris*.

Eurycles javanica Roemer, Prospect. Fam. Nat. Syn. Monogr. 4 (1847) 157, nom. illeg.; Miq., Fl. Ned. Indië 3 (1859) 582.

Bulb to 8 cm diam. *Leaves*: petiole 15–60 cm long; limb subcircular to broadly ovate, hardly cordate at base, emarginate to shortly apiculate, 20–30 cm long and 15–35 cm wide, margin undulate. *Umbel* 5–25-flowered; peduncle 15–90 cm long; spathes 3 or 4, 3–10 cm long; pedicels to 4.5 cm long. *Flowers* with 22–35 mm long perigone-tube, lobes 25–40 mm long. False corona 7–10 mm long; free part of filaments 10–12 mm long. *Fruits* 15–30 mm diam. — **Figs. 3, 4a, b.**

Distribution — Continental Asia (Thailand), Australia; in *Malesia*: Philippines (Luzon, Mindoro, Palawan), Celebes (Minahasa, Butung), Lesser Sunda Islands (Bali, Timor), Moluccas (Ambon), New Guinea (Merauke, Milne Bay, Fly River), Bismarck Archipelago. Also cultivated in gardens.

Habitat — Seashores and rocky places, up to 500 m altitude.

Subfamily Hypoxidoideae

Inflorescence a raceme, occasionally head-like or flowers solitary, with bracts but never spathes. *Flowers* actinomorphic. Tepals free or united into a tube. Stamens free or inserted on the perigone-tube.

Six genera.

CURCULIGO

Curculigo Gaertn., Fruct. Sem. Pl. 1 (1788) 63. — Type species: *Curculigo orchioides* Gaertn.

Gethyllis L., Sp. Pl. (1753) 442. — Type species: *Gethyllis afra* L.

Molineria Colla, Hort. Ripul., App. 2 (1826) 331. — Type species: *Molineria plicata* Colla, nom. illeg.

Thickly rhizomatous herbs, hairy or glabrous. *Leaves* radical, often petiolate, linear to broadly elliptic. *Inflorescences* racemes or spikes, sometimes head-like, many- to few-flowered. *Flowers* with the tepals united in a very short to elongate tube. Stamens free,

inserted at the mouth of the perigone-tube. *Fruits* fleshy, indehiscent or irregularly dehiscent, often with a persistent beak. — **Fig. 5.**

Distribution — About 20 species in the tropics; in *Malesia* 5 indigenous species and 1 variety; perhaps one species cultivated.

KEY TO THE SPECIES AND VARIETIES

- 1a. Leaves up to 20 cm long. Inflorescences lax, up to 8-flowered 4. *C. orchioides*
- b. Leaves usually longer than 20 cm. Inflorescences compact 2
- 2a. Inflorescences sessile or with scape to 4(–10) cm long. Fruit beaked 3
- b. Inflorescences with scape 5–30 cm long. Fruit beaked or not 4
- 3a. Perigone-tube 8–15 mm long 3a. *C. latifolia* var. *latifolia*
- b. Perigone-tube 20–40 mm long 3b. *C. latifolia* var. *megacarpa*
- 4a. Bracts glabrous or ciliate at the top. Perigone-tube 7–8 mm long. Fruit beaked
- 2. *C. erecta*
- b. Bracts villous to glabrescent. Perigone-tube to 2 mm long. Fruit not beaked 5
- 5a. Inflorescences head-like and deflexed 1. *C. capitulata*
- b. Inflorescences elongate and erect 5. *C. racemosa*

1. *Curculigo capitulata* (Lour.) Kuntze, Rev. Gen. Pl. 1 (1891) 703; Backer, Handb. Fl. Java 1 (1925) 104; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 213. — *Leucojum capitulatum* Lour., Fl. Cochinch. (1790) 199. — *Molineria capitulata* (Lour.) Herbert, Amaryll. (1837) 84; Backer & Bakh. f., Fl. Java 3 (1968) 209. — Type: unknown.

Curculigo recurvata Dryand. in Aiton, Hort. Kew., ed. 2, 2 (1814) 253; Miq., Fl. Ned. Indië 3 (1859) 585; Naves, Nov. App. (1880) 253; Koord., Meded. Lands Plantent. 19 (1898) 310; Ridley, Mat. Fl. Mal. Penins. 2 (1907) 65; Koord., Exk. Fl. Java 1 (1911) 304; Elmer, Leaflet. Philipp. Bot. 5 (1913) 1645; Hallier, Nova Guinea 8 (1913) 901; Laut., Bot. Jahrb. 50 (1913) 304; Ridley, Fl. Mal. Penins. 4 (1925) 299; Peekel, Fl. Bismarck Arch. Natur. (1984) 91. — *Molineria recurvata* (Dryand.) Herbert, Amaryll. (1837) 84. — Type: *Hort. Kew*, Bangladesh.

Curculigo glabra Merr., Philipp. J. Sc., Bot. 2 (1907) 267; Enum. Philipp. Flow. Pl. 1 (1925) 213. — Type: *Merrill 5750*, Mindoro.

Hairy herb. *Leaves* long-petiolate, elliptic to broadly elliptic, 60–150 cm long and 5–15 cm wide, nearly glabrous. *Inflorescence* a deflexed and head-like raceme, 2.5–7 cm long and wide; peduncle 7–30 cm long, tomentose to glabrescent at fructification; bracts brownish, 1.5–5 cm long,

villous to glabrescent at fructification. *Flowers* subsessile, yellow, villous. Perigone-tube 1–2 mm long; lobes 6–8 mm long. *Fruits* whitish to green, 10–15 mm long, not beaked. — **Fig. 5a.**

Distribution — Continental Asia (Nepal, India, Sri Lanka, Bangladesh, Thailand), Taiwan, Australia, Pacific Islands (Solomon Islands, Hawaii); *Malesia*: Sumatra, Malaya, Singapore, Java, Philippines (Luzon, Negros, Biliran, Mindanao), Celebes, Moluccas (Halmahera, Talaud, Ternate, Ambon), New Guinea, Manus I.

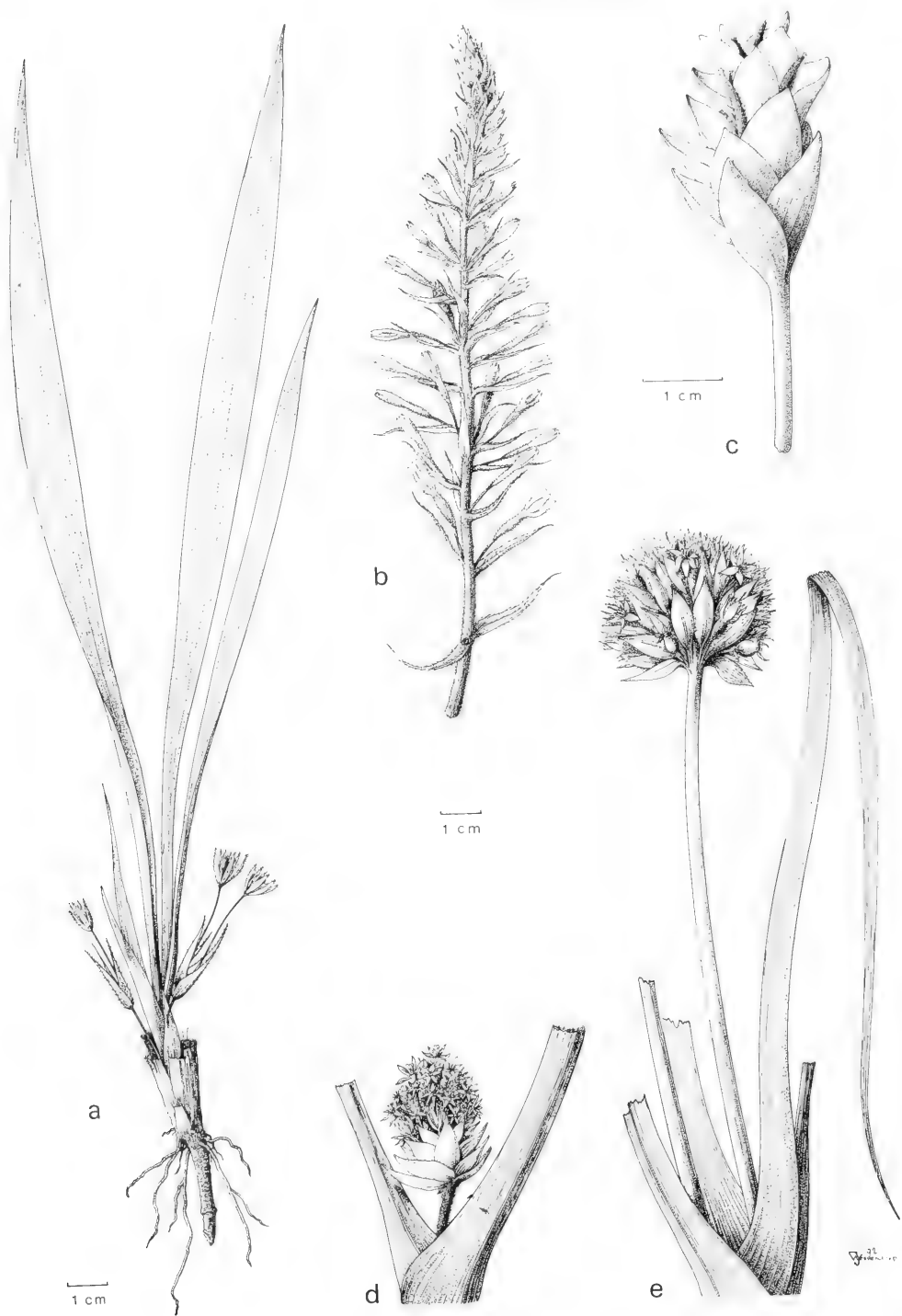
Habitat — Primary and secondary forests, from sea-level up to c. 2000 m altitude.

Uses — The fruits are edible. Leaf fibres are (or were) used in the Philippines, according to Burkill, Dict. Econ. Prod. Malay Penins. 1 (1935) 703.

2. *Curculigo erecta* Laut., Bot. Jahrb. 50 (Aug. 1913) 304. — Type: *Schulze 179*, Papua New Guinea, Sepik River.

Curculigo scapigera Hallier, Nova Guinea 8 (Sept. 1913) 901. — Type: *Versteeg 1084*, New Guinea.

Hairy herb. *Leaves* to 120 cm long and 6 cm wide. *Inflorescences* head-like, compactly ovoid to cylindrical, 2–4 cm long and 1–2 cm wide; peduncle tomentose to glabrescent, 5–30 cm long; bracts glabrous or ciliate at the top, to 2 cm long and 8 mm wide; pedicels c. 6 mm long. *Flowers* yellow. Perigone-tube 7–8 mm long. *Fruits* 10–18 mm long, beaked. — **Fig. 5b.**



Distribution — *Malesia*: E Sumatra, Philippines (Luzon), New Guinea (Irian Jaya). Not (yet) seen from Borneo and Celebes.

Habitat — Primary forest, montane forest, also in swamps. Altitudinal range uncertain.

3. *Curculigo latifolia* Dryand. in Aiton, Hort. Kew. ed. 2, 2 (1811) 253; Miq., Fl. Ned. Indië 3 (1859) 595; Ridley, Mat. Fl. Mal. Penins. 2 (1907) 66; Fl. Mal. Penins. 4 (1925) 300; Backer, Handb. Fl. Java 1 (1925) 104; Henderson, Mal. Wild Fl., Monocot. (1954) 167. — *Molineria latifolia* (Dryand.) Herbert ex Kurz, Nat. Tijds. Ned. Indië 27 (1864) 232; Backer & Bakh. f., Fl. Java 3 (1968) 209. — Type: *Hort. Kew*, India.

Curculigo glabrescens (Ridley) Merr., J. Str. Br. Roy. As. Soc. 85 (1922) 163. — *Curculigo latifolia* var. *glabrescens* Ridley, Mat. Fl. Mal. Penins. 2 (1907) 67. — Type: *Ridley*, Malaya.

Curculigo sumatrana Roxb., Fl. Ind. 2 (1824) 146; Ridley, Mat. Fl. Mal. Penins. 2 (1907) 66; Fl. Mal. Penins. 4 (1925) 300. — *Molineria sumatrana* (Roxb.) Herbert, Amaryll. (1837) 84. — Type: *Hort. Kew*, India.

Molineria plicata Colla, Hort. Ripul., App. 2 (1826) 331, pl. 18, nom. illeg.; Kurz in Miq., Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 176. — Type: Sumatra.

Curculigo villosa Wall. ex Kurz in Miq., Ann. Mus. Bot. Lugd.-Bat. 4 (1869) 176; Ridley, Fl. Mal. Penins. 4 (1925) 300. — *Curculigo latifolia* var. *villosa* (Wall. ex Kurz) Baker, J. Linn. Soc. 17 (1878) 125. — Type: *Wallich 5163A*, Singapore.

Curculigo agusanensis Elmer, Leaf. Philipp. Bot. 5 (1913) 1645; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 213. — Types: *Elmer 13584*, Mindanao, Mt Urdaneta.

Curculigo weberi Elmer, Leaf. Philipp. Bot. 5 (1913) 1646; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 213. — Type: *Elmer 14304*, Mindanao, Mt Urdaneta.

Curculigo brevipedunculata Elmer, Leaf. Philipp. Bot. 5 (1918) 1647; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 213. — Type: *Elmer 13164*, Palawan, Mt Pulgar.

Curculigo borneensis Merr., J. Str. Br. Roy. As. Soc. 85 (1922) 162. — Type: *Ramos 1712*, Borneo, Sandakan.

Hairy herb. *Leaves* long-petiolate, elliptic to broadly elliptic, 30–100 cm long and 5–10 cm wide, glabrous or nearly so. *Inflorescences* ovoid to cylindrical, compact, 2–6 cm long and wide, sessile or peduncle to 4(–10) cm long, glabrescent; bracts green, glabrous or ciliate at margins, 1–6 cm long. *Flowers* subsessile, yellow, villous. Perigone-tube 8–40 mm long; lobes 8–12 mm long. *Fruits* 10–25 mm long, beaked, white to green.

a. var. *latifolia*

Perigone-tube 8–15 mm long. — **Fig. 5c.**

Distribution — Continental Asia (India, Burma, Thailand); *Malesia*: Sumatra, Lingga, Bangka, Malaya (Pahang), Borneo (Sarawak, Sabah, Kalimantan), Java, Philippines (Palawan, Balabac, Samar), Celebes.

Habitat — Forests, at high altitudes.

Uses — The fruits are edible. Burkill, Dict. Econ. Prod. Mal. Penins. 1 (1935) 704 and Heyne, Nutt. Pl. Indonesië 1 (1950) 451 report the (former) use of rolled leaves as string and of extracted leaf-fibres for fishing nets etc. in Borneo and Malaya. Medicinal uses are also mentioned for Malaya (Burkill, l.c.).

Note — The specimen *Jacobs 5549* from Borneo shows three subsessile inflorescences and one with a peduncle 10 cm long.

b. var. *megacarpa* (Ridley) Geerinck, *comb. nov.* — *Curculigo megacarpa* Ridley, J. Str. Br. Roy. As. Soc. 41 (1904) 33; Mat. Fl. Mal. Penins. 1 (1907) 67; Fl. Mal. Penins. 4 (1925) 300. — Type: *Ridley*, Malaya, Perak, Taiping Hills.

Perigone-tube 20–40 mm long.

Distribution — Continental Asia (Thailand); *Malesia*: Malaya (Perak), Borneo (Sandakan), Java (also Panaitan I.).

Habitat — Rain forest, at high altitudes.

Note — Further material is necessary to confirm the rank of this taxon.

Fig. 5. *Curculigo capitulata* (Lour.) Kuntze. a. Inflorescence. — *C. erecta* Laut. b. Inflorescence. — *C. latifolia* Dryand. var. *latifolia*. c. Inflorescence. — *C. orchoides* Gaertn. d. Flowering plant. — *C. racemosa* Ridley. e. Inflorescence (a: *de Wilde & de Wilde-Duyfjes 13539*; b: *Brass 6994*; c: *Geesink & Hattink 6401*; d: *Zippel 272*; e: *Jacobs 5610*).

4. **Curculigo orchioides** Gaertn., Fruct. Sem. Pl. 1 (1788) 63; Miq., Fl. Ned. Indië 3 (1859) 585; Backer, Handb. Fl. Java 1 (1925) 103; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 213; Backer & Bakh. f., Fl. Java 3 (1968) 209. — Type: unknown.

Gethyllis acaulis Blanco, Fl. Filip. (1837) 260; Merr., Dep. Int. Bur. Gov. Labor. 27 (1905) 85. — Type: *Blanco*, Philippines, Manila.

Hairy herb. *Leaves* subpetiolate, linear to elliptic, to 20 cm long, 8 cm wide. *Inflorescence* lax, up to 8-flowered; bracts long-acuminate, 2–3.5 cm long, long-ciliate; pedicels 2–3 cm long. *Flowers* bright yellow. Perigone-tube 5–20 mm long; lobes c. 6.5 mm long. *Fruit* green, beaked. — **Fig. 5d.**

Distribution — Continental Asia (India, Laos, Cambodia, Vietnam, Thailand), Taiwan, Pacific Islands (Marianes, New Caledonia); *Malesia*: Sumatra, Borneo (Kalimantan), Java, Philippines (Luzon, Samar, Mindanao), Celebes, Lesser Sunda Islands (Sumba, Flores, Timor), Moluccas (Ambon), New Guinea, Misima I.

Habitat — Grassland, at low altitudes.

Uses — Medicinal use of roots is mentioned by Burkill (Dict. Econ. Prod. Malay Penins. 1, 1935,

703) and Quisumbing (Medic. Pl. Philipp. 1951, 172) on the strength of Indian literature.

5. **Curculigo racemosa** Ridley, J. Str. Br. Roy. As. Soc. 44 (1805) 198. — Type: *Ridley*, Borneo, Mt Matang.

Hairy herb. *Leaves* 50–100 cm long and 8–10 cm wide. *Inflorescence* elongate and erect; peduncle (10–)20–40 cm, tomentose; bracts to 2.5 cm long, 3 mm wide, villous; pedicels 8–15 mm long. *Flowers* bright yellow. Perigone-tube 1–2 mm long; lobes 6–12 mm long and 1.5–2 mm wide. *Fruits* green, 8–12 mm long, not beaked. — **Fig. 5e.**

Distribution — *Malesia*: Borneo (Sarawak, Sabah, Kalimantan).

Habitat — Rain forest, old secondary forest, at high altitudes.

Note — The specimen *Jacobs 5610* is said to be an epiphyte on a hollow tree trunk.

CULTIVATED SPECIES

Curculigo ensifolia R. Br. — Laut., Bot. Jahrb. 50 (1913) 304.

Native of Australia: perhaps a synonym of *C. orchioides* Gaertn.

HYPOXIS

Hypoxis L., Syst. Nat., ed. 10 (1789) 986.

Hairy or glabrous herbs, bulbous or thickly rhizomatous. *Leaves* radical, linear to narrowly elliptical. *Inflorescence* a 1- to many-flowered raceme; bracts narrow. *Flowers* with free tepals. Stamens free. *Fruit* a dry capsule, regularly dehiscent. — **Fig. 6.**

Distribution — About 100 species, predominantly in tropical Africa; one indigenous species in Malesia and one cultivated.

Hypoxis aurea Lour., Fl. Cochinch. (1790) 200; Ridley, Mat. Fl. Mal. Penins. 1 (1907) 64; Koord., Exk. Fl. Java 1 (1911) 305; Laut., Bot. Jahrb. 50 (1913) 305; Backer, Handb. Fl. Java 1 (1925) 105; Merr., Enum. Philipp. Flow. Pl. 1 (1925) 214; Backer & Bakh. f., Fl. Java 3 (1968) 209. — Type: *Loureiro*, Cochinchina, So Koug.

Hypoxis franquevillei Miq., Fl. Ned. Indië 3 (1859) 586; Naves, Nov. App. (1880) 253. — Type: *Franqueville*, Java, Penangoen.

Plant hairy; rootstock globose to elongate. *Leaves* linear to narrowly elliptic, acuminate, 8–25 cm long and 1–4 mm wide. *Inflorescences* 4–8 cm long, shorter than the leaves, 1- to few-flower-

ed; bracts linear; pedicels 1.5–4 mm long. *Flowers*: tepals 5–6 mm long and about 1.5 mm wide. *Capsules* about 7 mm long. — **Fig. 6.**

Distribution — Continental Asia (China, India, Cambodia, Thailand), Japan, Taiwan; *Malesia*: Sumatra, Malaya, Java, Philippines (Luzon, Mindanao), Celebes, Flores, New Guinea (Irian Jaya).

Habitat — Grassland and other sunny places, not at very low altitudes.

CULTIVATED SPECIES

Hypoxis hygrometrica Labill. — Laut., Bot. Jahrb. 50 (1913) 305.

Native of Australia; cultivated in New Guinea. Plant sparsely hairy; inflorescence 1–2-flowered.

CULTIVATED SPECIES
OF NON-MALESIAN GENERA

Amaryllis belladonna L. — Backer, Handb. Fl. Java 1 (1925) 85; Steiner, Philipp. Ornam. Pl. (1960) 136; Backer & Bakh. f., Fl. Java 3 (1968) 133.

Native of South Africa; cultivated as an ornamental. Umbel 6–12-flowered; perigone dark red or pink to white.

Clivia miniata (Lindley) Bosse — Backer, Handb. Fl. Java 1 (1925) 84; Backer & Bakh. f., Fl. Java 3 (1968) 133.

Native of South Africa; cultivated as an ornamental. Umbel 12–20-flowered; perigone usually orange.

Cooperia drummondii Herbert — Backer, Handb. Fl. Java 1 (1925) 87; Backer & Bakh. f., Fl. Java 3 (1968) 135.

Native of N America; cultivated as an ornamental. Perigone white, often tinged with violet.

Cyrtanthus mackenii Hook. f. — Backer, Handb. Fl. Java 1 (1925) 90; Backer & Bakh. f., Fl. Java 3 (1968) 137.

Native of South Africa; cultivated as an ornamental. Umbel 4–10-flowered; flowers fragrant; perigone 3.5–5 cm long, white to yellowish.

Cyrtanthus pallidus Sims — Backer, Handb. Fl. Java 1 (1925) 90; Backer & Bakh. f., Fl. Java 3 (1968) 137.

Native of South Africa; cultivated as an ornamental. Umbel 4–7-flowered; perigone pale pink, 4–5.5 cm long.

Eucharis amazonica Linden ex Planch. — Backer, Handb. Fl. Java 1 (1925) 92; Backer & Bakh. f., Fl. Java 3 (1968) 139. — *Eucharis grandiflora* auct. non Planch. & Linden: Merr., Enum. Philipp. Flow. Pl. 1 (1925) 211; Peekel, Fl. Bismarck Arch. Natur. (1984) 89.

Native of Colombia; cultivated as an ornamental. Leaves several per bulb; umbel 4–8-flowered; flowers fragrant; false corona white with greenish or yellowish stripes.

Eucharis candida Planch. & Linden — Koord., Exk. Fl. Java 1 (1911) 303; Backer, Handb. Fl. Java 1 (1925) 92; Backer & Bakh. f., Fl. Java 3 (1968) 139.

Native of Colombia; cultivated as an ornamental. Leaf 1 per bulb; umbel 6–10-flowered; flowers fragrant; false corona yellow.



Fig. 6. *Hypoxis aurea* Lour. Flowering plant (Brass 11783).

Eucharis mastersii Baker — *Eucharis grandiflora* auct. non Planch. & Linden: Koord., Exk. Fl. Java 1 (1911) 303; Backer, Handb. Fl. Java 1 (1925) 92; Steiner, Philipp. Orn. Pl. (1960) 137; Backer & Bakh. f., Fl. Java 3 (1968) 139.

Native of Colombia; cultivated as an ornamental. Leaves several per bulb; umbel 2–5-flowered; flowers fragrant in the evening; false corona green and yellow.

Eucharis sanderi Baker — Backer, Handb. Fl. Java 1 (1925) 92; Backer & Bakh. f., Fl. Java 3 (1968) 139.

Native of Colombia; probably a hybrid between the two preceding species; perhaps cultivated as an ornamental. Umbel 2–3-flowered.

Eucharis subdentata Baker — Backer, Handb. Fl. Java 1 (1925) 92; Backer & Bakh. f., Fl. Java 3 (1968) 139.

Native of Colombia; cultivated as an ornamental. Leaves several per bulb; umbel 6–8-flowered; false corona not toothed.

Griffinia ornata Moore — Backer, Handb. Fl. Java 1 (1925) 84; Backer & Bakh. f., Fl. Java 3 (1968) 133.

Native of Brazil; cultivated as an ornamental. Umbels 10–16-flowered; perigone violet.

Hippeastrum advenum Ker-Gawl. — Backer, Handb. Fl. Java 1 (1925) 96; Backer & Bakh. f., Fl. Java 3 (1968) 142.

Native of Chile; cultivated as an ornamental. Perigone-lobes 3.5–4.5 cm long, red, pink or yellow.

Hippeastrum aulicum (Ker-Gawl.) Herbert — Laut., Bot. Jahrb. 50 (1913) 303; Backer, Handb. Fl. Java 1 (1925) 96; Backer & Bakh. f., Fl. Java 3 (1968) 142; Peekel, Fl. Bismarck Arch. Natur. (1984) 89.

Native of Brazil; cultivated as an ornamental. Perigone-lobes 9–15 cm long, red with darker veins.

Hippeastrum pratense (Poepp.) Baker — Backer, Handb. Fl. Java 1 (1925) 96; Backer & Bakh. f., Fl. Java 3 (1968) 142.

Native of Chile; cultivated as an ornamental. Perigone-lobes 6–6.5 cm long, bright red to purple.

Hippeastrum puniceum (Lam.) Kuntze — Backer & Bakh. f., Fl. Java 3 (1968) 143. — *Hippeastrum equestre* (Ait.) Herbert: Koord., Exk. Fl. Java 1 (1911) 303; Backer, Handb. Fl. Java 1 (1925) 97; Steiner, Philipp. Orn. Pl. (1960) 137.

Native of Central America and West Indies; cultivated as an ornamental. Perigone-lobes red to orange-red and greenish to whitish at base.

Hippeastrum reginae (L.) Herbert — Backer, Handb. Fl. Java 1 (1925) 97; Backer & Bakh. f., Fl. Java 3 (1968) 142. — *Amaryllis atamasco* auct. non L.: Blanco, Fl. Filip. (1837) 254. — *Hippeastrum miniatum* auct. non Herbert: Merr., Enum. Philipp. Flow. Pl. 1 (1925) 212.

Native of tropical America; cultivated as an ornamental. Perigone-lobes 8–12 cm long, red with greenish 5-pointed star at base.

Hippeastrum reticulatum (L'Hér.) Herbert — Laut., Bot. Jahrb. 50 (1913) 302; Backer, Handb. Fl. Java 1 (1925) 97; Steiner, Philipp. Orn. Pl. (1960) 137; Backer & Bakh. f., Fl. Java 3 (1968) 142; Chin, Malays. Fl. Col. (1974) 145; Peekel, Fl. Bismarck Arch. Natur. (1984) 87.

Native of Brazil; cultivated as an ornamental. Perigone-lobes 10–12.5 cm long, red-mauve with darker veins.

Hippeastrum rutilum Ker-Gawl. — *Hippeastrum splendens* Herbert: Backer, Handb. Fl. Java 1 (1925) 97; Backer & Bakh. f., Fl. Java 3 (1968) 142.

Native of Brazil; cultivated as an ornamental. Perigone-lobes 8–12 cm long, greenish and apically red.

Hippeastrum stylosum Herbert — Backer, Handb. Fl. Java 1 (1925) 97; Backer & Bakh. f., Fl. Java 3 (1968) 142.

Native of Guyana and Brazil; cultivated as an ornamental. Perigone-lobes c. 10 cm long, bright red with a pale median band.

Hippeastrum vittatum (L'Hér.) Herbert — Backer, Handb. Fl. Java 1 (1925) 97; Backer & Bakh. f., Fl. Java 3 (1968) 299.

Native of Peru and Brazil; cultivated as an ornamental. Perigone-lobes 7.5–15 cm long, white with red stripes.

Leucojum aestivum L. — Backer & Bakh. f., Fl. Java 3 (1968) 144.

Native to S Europe; cultivated as an ornamental. Umbel 3–5(–7)-flowered; perigone-lobes 1–1.5 cm long.

Narcissus jonquilla L. — Backer, Handb. Fl. Java 1 (1925) 94; Backer & Bakh. f., Fl. Java 3 (1968) 140. — *Narcissus pseudonarcissus* auct. non L. (?): Koord., Exk. Fl. Java 1 (1911) 303.

Native of S Europe; cultivated as an ornamental. Umbel 2–5-flowered; flowers fragrant; perigone green and yellow.

Narcissus tazetta L. — Backer, Handb. Fl. Java 1 (1925) 94; Backer & Bakh. f., Fl. Java 3 (1968) 140. — *Narcissus poeticus* auct. non L. (?): Koord., Exk. Fl. Java 1 (1911) 303.

Native to S Europe and temperate Asia; cultivated as an ornamental. Umbel 3–20-flowered; perigone whitish.

Scadoxus multiflorus (Martyn) Raf. — *Haemanthus multiflorus* Martyn: Backer, Handb. Fl. Java 1 (1925) 83; Steiner, Philipp. Orn. Pl. (1960) 137; Backer & Bakh. f., Fl. Java 3 (1968) 132; Chin, Malays. Fl. Col. (1974) 143. — *Haemanthus puniceus* auct. non L.: Koord., Exk. Fl. Java 1 (1911) 302.

Native of tropical Africa; cultivated as an ornamental. Umbel spherical or hemispherical; perigone red to pink.

Sprekelia formosissima (L.) Herbert — Backer, Handb. Fl. Java 1 (1925) 96; Backer & Bakh. f., Fl. Java 3 (1968) 141.

Native of Mexico and Guatemala; cultivated as an ornamental. Perigone usually dark red, 9–12 cm long. Poisonous.

Vallota speciosa (L.f.) Dur. & Schinz — Backer, Handb. Fl. Java 1 (1925) 85; Backer & Bakh. f., Fl. Java 3 (1968) 133.

Native of South Africa; cultivated as an ornamental. Umbel 4–9-flowered; perigone red to white.

Zephyranthes atamasco (L.) Herbert — Backer, Handb. Fl. Java 1 (1925) 86; Steiner, Philipp. Orn. Pl. (1960) 138; Backer & Bakh. f., Fl. Java 3 (1968) 135.

Native of N America; cultivated as an ornamental. Perigone about 7.5 cm long, white.

Zephyranthes brachyandra (Baker) Backer — Backer & Bakh. f., Fl. Java 3 (1968) 134.

Native of Paraguay. Cultivated as an ornamental. Perigone 3–3.5 cm long, violet.

Zephyranthes candida (Lindley) Herbert — Backer, Handb. Fl. Java 1 (1925) 86; Backer & Bakh. f., Fl. Java 3 (1968) 135; Peekel, Fl. Bismarck Arch. Natur. (1984) 87.

Native of S America; cultivated as an ornamental and subnaturalized. Perigone about 1.5 cm long, white slightly tinged with red.

Zephyranthes carinata Herbert — Backer, Handb. Fl. Java 1 (1925) 86; Steiner, Philipp. Orn. Pl. (1960) 138; Backer & Bakh. f., Fl. Java 3 (1968) 134.

Native of S America; cultivated as an ornamental. Perigone 2.5–4.5 cm long, light pink.

Zephyranthes citrina Baker — Backer, Handb. Fl. Java 1 (1925) 85; Backer & Bakh. f., Fl. Java 3 (1968) 134.

Native of British Guyana; cultivated as an ornamental. Perigone 2–2.5 cm long, bright yellow.

Zephyranthes grandiflora Lindley — Backer, Handb. Fl. Java 1 (1925) 86; Backer & Bakh. f., Fl. Java 3 (1968) 135. — *Zephyranthes carinata* Herbert: Backer, Handb. Fl. Java 1 (1925) 86; Backer & Bakh. f., Fl. Java 3 (1968) 134.

Native of Central America; cultivated as an ornamental. Perigone 6–7.5 cm long, light pink.

Zephyranthes mesochloa auct. non Herbert (?): Koord., Meded. Lands Plantent. 19 (1898) 311.

Zephyranthes rosea (Sprengel) Lindley — Backer, Handb. Fl. Java 1 (1925) 86; Koord., Exk. Fl. Java 1 (1911) 302; Laut., Bot. Jahrb. 50 (1913) 302; Steiner, Philipp. Orn. Pl. (1960) 138; Backer & Bakh. f., Fl. Java 3 (1968) 134; Peekel, Fl. Bismarck Arch. Natur. (1984) 85. — *Atamasco rosea* (Sprengel) Greene: Merr., Enum. Philipp. Flow. Pl. 1 (1925) 210. Native of Cuba. Cultivated as an ornamental and subnaturalized. Perigone 3–3.5 cm long, pink.

Zephyranthes tubispatha (L'Hér.) Herbert — Backer, Handb. Fl. Java 1 (1925) 87; Backer & Bakh. f., Fl. Java 3 (1968) 135; Peekel, Fl. Bismarck Arch. Natur. (1984) 87.

Native of Central and South America; cultivated as an ornamental. Perigone 4–5 cm long, white, tinged with green.

Zephyranthes verecunda Herbert — Backer, Handb. Fl. Java 1 (1925) 86; Backer & Bakh. f., Fl. Java 3 (1968) 135.

Native of Mexico; cultivated as an ornamental. Perigone 3.5–5 cm long, white, tinged with pink.

ALLIACEAE

(J.R.M. Buijsen¹, Leiden, The Netherlands)

Alliaceae Agardh, Theor. Syst. Pl. (1858) 32; Dahlgren, Clifford & Yeo, Fam. Monocot. (1985) 193–196. — *Liliaceae* subfam. *Allioideae*, Melchior in Melchior, Syll. Pflanzenfam. ed. 12 (1964) 521.

Perennial herbs with bulbs, bulb-like corms or rhizomes. *Leaves* simple, basally concentrated, spirally set or distichous. *Inflorescence* usually umbellate and with 1, 2 or more membranous spathes. *Flowers* generally bisexual, actinomorphic or sometimes zygomorphic. *Tepals* in 2 whorls, free or often connate, forming a campanulate or tubular perianth with erect, spreading or sometimes recurved lobes. *Stamens* usually 6 or sometimes 5 with several staminodes, free, inserted at the base of the tepals or in the perigone-tube; anthers dorsifixed. *Ovary* superior, 3-celled, with axillary placentas, septal nectary grooves present on the ovary; ovules 2 to several per locule. *Fruit* a loculicidal capsule. *Seeds* often half-ovoid, half-globose or tetrahedral and triangular in transection, sometimes ovoid or ellipsoid to subglobose and rounded in transection.

Distribution — As circumscribed by Dahlgren et al. (1985) this segregate from *Liliaceae* s.l. comprises the South African *Agapanthoideae*, the mainly Chilean *Gilliesioideae*, and *Allioideae* with the neogeic tribe *Brodiaeeae* and the nearly cosmopolitan *Allieae*.

Taxonomy — The taxonomic position of the genus *Allium* and related genera is still disputed. Earlier botanists (e.g., Engler, Bentham, and Hooker) placed them in the *Liliaceae*, as recently followed again by, e.g., Cronquist (1981) and Mabberley (1987). Alternatively, they were included in the *Amaryllidaceae* by, e.g., Hutchinson and Traub (see Hanelt 1990). Often also *Allium* and its close relatives are recognized as a distinct family *Alliaceae*, close to the *Amaryllidaceae* (Dahlgren et al. 1985). This controversy does not matter much for Malesia since only *Allium* and *Nothoscordum* are found there, both not indigenous.

References: Cronquist, A., Integrated system of classification of Flowering Plants (1981) 1208. — Dahlgren, R.M.T., H.T. Clifford & P.F. Yeo, The families of the Monocotyledons (1985) 193. — Hanelt, P., in H.D. Rabinowitch & J.L. Brewster (eds.), Onions and allied crops, Vol. 1 (1990) 2. — Mabberley, D.J., The Plant-Book (1987) 331.

Palynology — The approximately 34 genera that make up the *Alliaceae* (see Dahlgren & Clifford 1982) are palynologically rather poorly known. Pollen of representatives of 20 genera has been described (Tissot 1990), but nearly always with light microscopy only. The most comprehensive works include Heusser (1971) and Schulze (1980). Beug (1961),

¹) The International Board for Plant Genetic Resources IBPGR financed a taxonomic survey of *Allium* species cultivated in SE Asia, that included a collection trip to Java in 1989.

Radulescu (1973), Kuprianova & Aliev (1979) and Pastor (1981) give more or less extensive accounts on *Allium* pollen. Pollen of *Nothoscordum*, the other genus found in Malesia, is dealt with by Schulze (l.c.).

Pollen grain size (length of largest equatorial axis) in *Alliaceae* is usually 25–55 μm . Several genera have significantly larger pollen: *Agapanthus* (up to 75 μm), *Brodiaea* (up to 78 μm), *Dichelostemma* (up to 70 μm), *Milla* (69–115 μm) and *Triteleia* (up to 72 μm). The aperture system is always monosulcate. The sulcus is nearly as long as the long equatorial axis and restricted to the distal grain side, or it may continue on both ends on the proximal side. Exine thickness is usually 1–2 μm , rarely < 1 μm or 2–3 μm . The exine is columellate, and tectate or semitectate. The sexine is always thicker than the nexine. Ornamentation varies from psilate with (very) small perforations to reticulate. The diameter of the perforations/lumina is mostly 0.5–1.5 μm . Reticulate ornamentation with larger lumina is found in pollen of *Dichelostemma* (1.5–4 μm), *Milla* (3–7 μm) and *Muilla* (1.5–4 μm). Reticulate ornamentation is usually heterobrochate, i.e. with lumina of different sizes mingled on the proximal grain side. Towards the sulcus lumen size more or less gradually decreases. Finely striate-rugulate ornamentation with minute perforations was found in *Allium* using scanning electron microscopy (Pastor 1981).

The *Alliaceae* is a stenopalynous family. Palynologically the subfamilies are not distinct from each other. In the *Allioideae* two groups might be distinguished (Schulze l.c.). On infrageneric level the length of the sulcus may sometimes be of taxonomic significance, for example in *Allium* (Kuprianova & Aliev l.c.; Pastor l.c.). Pollen like that of the *Alliaceae* occurs in many other monocot families.

References: Beug, H.-J., Leitfaden der Pollenbestimmung (1961). — Dahlgren, R. M. T. & H. T. Clifford, The monocotyledons: a comparative study (1982). — Heusser, C. J., Pollen and spores of Chile (1971). — Kuprianova, L. A. & T. A. Aliev, Bot. Zhurn. 64 (1979) 1273–1284. — Pastor, J., Bot. Macaronesica 8/9 (1981) 189–214. — Radulescu, D., Acta Bot. Hort. Bucur. 1972–73 (1973) 133–248. — Schulze, W., Wiss. Z. Friedr.-Schiller-Univ. Jena, Math.-Naturwiss. R. 29 (1980) 595–606. — Tissot, C., Sixth bibliographic index to the pollen morphology of Angiosperms (1990).

R. W. J. M. van der Ham

Phytochemistry (compare also the relevant chapter under *Amaryllidaceae*) — All members of *Allium* emit after wounding characteristic odours known as ‘onion odour’ and ‘garlic odour’. Everywhere mankind met species of *Allium*, it made use of their spicy, culinary and medicinal properties. *Allium* taxa, including a lot of cultivars of the onion group (*A. cepa*), the garlic group (*A. sativum*) and the leek group (*A. porrum*), are cultivated from time immemorial in southern Europe and the Near East. *Allium kurrat* seems to have been taken in cultivation in ancient Arabia, Palestina and Egypt and *A. chinense*, *fistulosum*, *macrostemon* and *tuberosum* had or still have many ancient cultivars from India to China and Japan. Chives (*A. schoenoprasum*) were taken in cultivation in postroman time in Europe.

There are three classes of secondary metabolites which apparently are produced by all species of *Allium*. Firstly a range of sulphur compounds which originate all after wounding from genuine S-alkyl- and S-alkenylcysteines and are responsible for the characteristic odour. Secondly complex mixtures of biologically active saponins with C₂₇ steroidal saponinogens. Thirdly phenolic compounds which seem to be mainly derivatives of the flavonols

kaempferol and quercetin and simple phenolic acids such as protocatechuic and ferulic acid. Perhaps biogenic amines and simple amides and alkaloids represent another group of characteristic *Allium* metabolites.

The totality of the presently known chemical compounds indicates that *Allium*, and possibly *Allioideae*, have one taxon-characteristic chemical character, namely production of S-alkylated cysteines. By their saponins *Allioideae* are reminiscent of that part of *Liliiflorae* which is classified by Dahlgren et al. (1985) in *Dioscoreales* and *Asparagales*. Biochemically *Allioideae* are clearly distinct from *Amaryllidaceae* s.str., *Haemodoraceae*, *Hypoxidaceae* and all the families reunited in *Liliales* sensu Dahlgren et al. (1985).

Phytochemistry and chemotaxonomy of *Alliaceae* were discussed twice by Hegnauer (1963, 1986) sub *Liliaceae*; in these treatises many references can be found. Some results of recent phytochemical investigations will shortly be mentioned in the following alineas.

Sulphur compounds are usually considered to be mainly responsible for the medicinal virtues of garlic and other species of *Allium*. This initiated a large number of chemical, analytical and medicinal publications; see e.g. Ziegler et al. (1989), Sticher (1991), Block (1992), Hikino et al. (1986) and others. The S-alkylated cysteines are stored in fresh bulbs, leaves and seeds of *Allium* species as γ -glutamyl peptides. During long storage or on wounding a lot of mostly enzymatic transformations can take place, e.g.: generation of the free S-alkylated cysteines; oxidation to S-alkylated cysteine sulfoxides (the S-allyl-derivative is alliin); transformation of the sulfoxides to dialkyl thiosulfinates (the diallyl-derivative is allicin); this last step is catalysed by the enzyme alliinase which is only known from the genera *Allium* and *Nothoscordum*. S-*trans*-1-propenylcysteine (the precursor of the lachrimatory factor of onion), S-allyl-cysteine (the precursor of alliin and allicin), S-methylcysteine and S-propylcysteine occur in variable amounts and proportions in different species of *Allium* (Lawson et al. 1991). New transformation products of allicin are the ajoenes and the vinylthiins of *A. sativum* (Sticher 1991). Onions produce on grating and slicing variable amounts of thiopropanal-S-oxide (lachrimatory factor), 2-methyl-2-pentenal, propanethiol, dipropyldisulfide, propenyl-propyldisulfide and others (Tokitomo & Kobayashi 1992). The cepaenes and deoxycepaenes of *A. cepa* are isomers of the *A. sativum* ajoenes (Block & Zhao 1992). Other types of sulphur compounds were isolated from subterranean parts of *Tulbaghia violacea* (Burton et al. 1992).

All species of *Allium* produce monodesmosidic spirostanol-type and bidesmosidic furostanol-type steroidal saponins. A review treating 26 species, 26 sapogenins and 40 saponins was published by Kravets et al. (1990). Of the sapogenins mentioned agiogenin, alliogenin, the ansurogenins, cepagenin, gantogenin, the karatavigenins, luvigenin, neoagiogenin and its 6-benzoate and neoalligenin are new C₂₇-spirostanols. Agiogenin was first isolated from *A. giganteum* (therefore not aiogenin: Dahlgren et al. 1985: 195). New saponins were isolated among others from bulbs of *A. ampeloprasum* (Morita et al. 1988), bulbs of *A. chinense* (Matsuura et al. 1989a), bulbs of *A. giganteum* (Sashida et al. 1991), flowers of *A. porrum* (Harmatha et al. 1987), bulbs and roots, but not leaves, of *A. sativum* (Matsuura et al. 1988, 1989b) and bulbs of *A. vineale* (Chen & Snyder 1987, 1989). The *vineale* saponins have molluscicidal activity; the leek saponin aginoside is concentrated in flowers and makes them unpalatable and toxic for larvae of the leek moth; the spirostanolsaponins aginosideprosapogenin and ampelocide-Bs₁ of *A. ampeloprasum* are

fungitoxic whereas the bidesmosidic furostanol saponins ampeloside-Bf₁ and -Bf₂ did not inhibit the two species of Fungi tested; the same biological properties were observed in *A. sativum* with the fungitoxic eruboside-B, a spirostanolic β -chlorogenin-3-glycoside, and the inactive bidesmosidic furostanols proto-eruboside-B, sativoside-B1 and sativoside-R1. Bulbs of *Tristagma uniflora* yielded saponins with tigogenin, neotigogenin, two 25-epimeric 5 α ,6-dihydronuatigenins and two 25-epimeric 5 α ,6-dihydroisouatigenins as aglycones (Brunengo et al. 1985). According to Koch (1992) the steroidal sapogenins may be involved in some of the therapeutical effects of onion and garlic.

Commercially available fresh leaves of *A. tuberosum* yielded three new kaempferol bis- and tris-glycosides with one of the sugar hydroxyls acylated by ferulic acid, a kaempferol and a quercetin 3,4'-bisglucoside and kaempferol-3-sophoroside (Yoshida et al. 1987).

Bulbs of *A. chinense* (= *A. bakeri*) yielded diallyl disulfide, the dihydrostilbene lunularic acid and the amides N-*p*-coumaroyltyramine and N-feruloyltyramine (Okuyama et al. 1986; Goda et al. 1987). Another amide, aurantiamide acetate, was isolated from whole plants of *A. wallichii* (Talapatra et al. 1989); these authors also reported isolation of the furanocoumarin imperatorin from the same plant without giving yields nor mentioning vouchers. A simple alkaloid related to N-methyltyramine and called alline (do not confound with alliin) was isolated from *A. ramosum* (= *A. odorum*) (Tashkhodzhaev et al. 1985) and sequently demonstrated to occur also in *A. altaicum*, *anisopodium*, *senescens*, *splendens*, *stellerianum* and *victoralis*, but not in *A. leucocephalum* and *A. schoenoprasum* var. *sibiricum* (Antsupova & Polozhiy 1987).

Bulbs of all investigated *Allium* species store fructans (Hegnauer 1963; Deinko 1985) and seeds store fatty oils with much linoleic acid (Hegnauer 1963; see for unsaturated fatty acids of *Allium* taxa also Deinko 1985). According to Afzal et al. (1985) lipids of bulbs of *A. sativum* contain much polyunsaturated fatty acids, such as linoleic, arachidonic (= eicosa-all-*cis*-5,8,11,14-tetraenoic) and an eicosapentaenoic acid.

Phytoalexins were induced in bulb scales of *A. cepa* by *Botrytis cinerea*, and subsequently two fungistatic compounds could be isolated; they were called tsibulin-1, C₁₁H₁₈O₂, and -2, C₁₃H₂₂O₂, after the Ukrainian name 'tsibulya' for onion; the tsibulins are 1-alkylcyclopentan-2,4-diones (Tverskoy et al. 1991).

Van Damme et al. (1991) prepared lectins from bulbs of five species of *Allium* and compared them with lectins of bulbs of six species of *Amaryllidaceae* s.str.; the taxonomic meaning of these results is not yet clear.

References: Afzal, M., et al., Agric. Biol. Chem. 49 (1985) 1187. — Antsupova, T.P. & A.V. Polozhiy, Rast. Resur. 23 (1987) 436. — Block, E., Organosulphur chemistry of Allium, Angew. Chemie, Intern. Ed. 31 (1992) 1135. — Block, E. & S.-H. Zhao, J. Org. Chem. 57 (1992) 5815. — Brunengo, M.C., et al., Phytochemistry 24 (1985) 1388. — Burton, S.G., et al., Planta Medica 58 (1992) 295. — Chen Shaoxing & J.K. Snyder, Tetrahedron Letters 28 (1987) 5603; J. Org. Chem. 54 (1989) 3679. — Dahlgren, R.M.T., H.T. Clifford & P.F. Yeo, The families of the Monocotyledons (1985). — Deinko, G.I., Rast. Resur. 21 (1985) 221 (lipids, fatty acids, carbohydrates). — Goda, Y., et al., Chem. Pharm. Bull. 35 (1987) 2668. — Harmatha, J., et al., Biochem. Syst. Ecol. 15 (1987) 113. — Hegnauer, R., Chemotaxonomie der Pflanzen 2 (1963) 281, 315–325, 488–489, 501; ibid. 7 (1986) 685–731, 803. — Hikino, H., et al., Planta Medica 52 (1986) 163 (antihepatotoxic action of garlic). — Koch, H.P., Zeitschr. Phytotherapie 13 (1992) 177 (ethnopharmacology of onion and garlic; modern pharmacological

and clinical studies). — Kravets, S.D., et al., *Khim. Prirod. Soedin.* (1990) 429. — Lawson, D.A., et al., *J. Nat. Prod.* 54 (1991) 436. — Matsuura, H., et al., *Chem. Pharm. Bull.* 36 (1988) 3659; *ibid.* 37 (1989a) 1390 (chinensoside-I); *ibid.* 37 (1989b) 2741. — Morita, T., et al., *Chem. Pharm. Bull.* 36 (1988) 3480. — Okuyama, T., et al., *Planta Medica* 52 (1986) 171. — Sashida, Y., et al., *Chem. Pharm. Bull.* 39 (1991) 698 (new alliogenin derivatives). — Sticher, O., *Deutsch. Apoth. Z.* 131 (1991) 403 (active principles of garlic and their analytical control). — Talapatra, S.K., et al., *Indian J. Chem.* 28B (1989) 356. — Tashkhodzhaev, B., et al., *Khim. Prirod. Soedin.* (1985) 687. — Tokitomo, Y. & A. Kobayashi, *Biosci. Biotechn. Biochem.* 56 (1992) 1865. — Tverskoy, L., et al., *Phytochemistry* 30 (1991) 799. — Van Damme, E.J.M., et al., *Phytochemistry* 30 (1991) 509. — Yoshida, T., et al., *Chem. Pharm. Bull.* 35 (1987) 97. — Ziegler, S.J., et al., *Deutsch. Apoth. Z.* 129 (1989) 318 (analytical control of garlic preparations).

R. Hegnauer

KEY TO THE GENERA IN MALESIA

- 1a. Bruised leaves strongly smelling. Ovules 2 per locule (in the Malesian species); tepals free or basally shortly connate **Allium** (p. 379)
- b. Bruised leaves not or hardly smelling. Ovules many per locule; tepals basally shortly connate **Nothoscordum** (p. 384)

ALLIUM

Allium L., *Sp. Pl.* 1 (1753) 294. — Type species: *Allium sativum* L.

Herbs, usually with onion-smell, bulbs often present, sometimes with short rhizomes, growing gregarious or not. *Leaves* linear to elliptic, sheathing the scape, the blades subapproximate or scattered along the scape, flat, or terete, semiterete, or angular and hollow. Scape terete or angular. *Inflorescence* umbellate, usually many-flowered, sometimes with bulbils, hemispherical to spherical or \pm ellipsoid, enveloped by 1 or 2 green or scarious, persistent or caducous spathe(s). *Flowers* relatively small, white to pinkish or purplish, bluish, or yellowish, stellate to campanulate or urceolate. *Tepals* 6, (sub)equal in length, elliptic to lanceolate, free or usually shortly connate at base, persistent. *Stamens* 6; filaments simple or tricuspidate. *Ovary* with 2–14 ovules per locule; style slender, erect; stigma usually inconspicuous, single or 3-lobed. *Fruit* capsular, loculicidally 3-valved. *Seeds* 1–4 per locule, flattened, irregularly angled, blackish.

Distribution — Indigenous to the Northern Hemisphere, with at present about 500–700 species. In Malesia some taxa are cultivated, all are introduced, either from China, Central Asia, or Europe. They are all well-known *Allium* crops, grown worldwide.

Uses — Of *Allium* plants the bulbs, cloves, pseudo-stems, leaves, and young inflorescences are used as vegetable and condiment. *Allium* species are also widely used in different medicines for treating various diseases, e.g., diarrhoea, eye-infections, and headaches. Nowadays lowering of the blood pressure and inhibition of blood plate aggregation are considered the most important medical effects of *Allium* consumption. Many *Allium* species are grown as ornamentals; however, not so in Malesia because *Allium* species usually do not flower under tropical conditions. For a more elaborate treatment of the cultivated *Allium* species in SE Asia see Siemonsma & Kasem Piluek (eds.), *Pl. Res. SE*

Asia (PROSEA Handb. 8, Vegetables) (1993). See also: Backer & Bakh. f., Fl. Java 3 (1968) 130–132; Burkill, Dict. Econ. Prod. Malay Penins. (1935) 98–103; Herklots, Veget. SE Asia (1972) 387–401; Heyne, Nutt. Pl. Ned.-Indië, ed. 2 (1927) 439–442; Jones & Mann, Onions and their allies. Botany, Cultivation, and Utilization (1963); Ochse & Bakh., Veget. Dutch East Indies (1931) 440–457; Purselove, Trop. Crops Monocot. (1972) 37–57; Rabinowitch & Brewster (eds.), Onions and allied crops, Vol. 1 (1990).

KEY TO THE SPECIES CULTIVATED IN MALESIA

Where possible, vegetative characters are used, but sometimes additional generative characters are given. Often young plants with immature bulbs are sold as vegetable. In that case characters of the bulb are not fully reliable and other characters, e.g. leaves, should be checked.

- 1a. Leaves terete or semiterete, or 3–5-angled, hollow 2
- b. Leaves flat, sometimes V-shaped or keeled, not hollow 6
- 2a. Leaves terete or semiterete, with a wide central cavity, easily compressible, usually diameter more than 5 mm (except *A. schoenoprasum* with a diameter of 1–5(–7) mm) 3
- b. Leaves 3- or 5-angled, with a narrow central cavity, diameter 1–5 mm

3. *A. chinense*
- 3a. Leaves terete, sometimes a few semiterete (check several leaves); mature bulbs distinct or indistinct, (narrowly) oblong to (narrowly) ovoid to elliptic 4
- b. Leaves semiterete, flattened on upper surface (check several leaves); mature bulbs distinct, depressed globose to ovoid or obovoid (immature bulbs of multiplier shallot are narrowly oblong to narrowly ovoid). Variable! **2. *A. cepa***
- 4a. Bulbs indistinct, diameter of bulb and neck equal or diameter bulb up to 1.5 times larger than diameter of neck 5
- b. Bulbs distinct, diameter bulb 1.5–2 times larger than diameter neck

***A. × proliferum* Wakegi Group (see note under 4. *A. fistulosum*)**
- 5a. Coarse plants; leaves fistulose, swollen in the centre, gradually tapering towards both ends, usually diameter more than 5 mm; flowers pale yellow; stamens exceeding the tepals **4. *A. fistulosum***
- b. Plants of finer habit; leaves fistulose, not swollen, usually diameter less than 5 mm; flowers usually purple, rarely white; stamens shorter than tepals

6. *A. schoenoprasum*
- 6a. Bulbs not set on a rhizome; leaves 20–60 cm by 10–35 mm 7
- b. Bulbs with several closely together on a rhizome; leaves 13–45 cm by 2–10 mm

7. *A. tuberosum*
- 7a. Mature bulbs indistinct, ovoid to oblong, not composed of increase bulbs, increase bulbs (if present) much smaller than main bulb **1. *A. ampeloprasum***
- b. Mature bulbs distinct, depressed globose to ovoid, composed of cloves (increase bulbs), cloves as long as main bulb (immature plants of *A. sativum* resemble *A. ampeloprasum* but can be distinguished by the presence of cloves within the inner bulb-coat-leaves and by a typical garlic-smell) **5. *A. sativum***

1. *Allium ampeloprasum* L., Sp. Pl. 1 (1753) 294.

Allium porrum L., Sp. Pl. 1 (1753) 295.

Bulb indistinct, ovoid to oblong, diameter up to c. 5 cm, gradually passing into the pseudo-stem. Increase bulbs absent, few, or many, situated within the outer bulbcoat-leaves. *Foliage leaves* 5–14, suberect, upper part curved, flat, V-shaped in cross section, up to 60 by 1–3.5 cm; sheaths extending much above the ground, forming a pseudo-stem. *Inflorescence* (hemi)spherical. *Flowers* usually campanulate, sometimes urceolate; tepals white to purple; stamens slightly shorter to longer than tepals.

Distribution – *Allium ampeloprasum* ranges as a wild plant from S Europe and N Africa through the Middle East into W and S Russia. A cultivated form, also known as *A. porrum*, is grown mainly in N Europe.

Common name – Leek (*A. porrum*).

2. *Allium cepa* L., Sp. Pl. 1 (1753) 300.

Bulb distinct, depressed globose to ovoid or obovoid, diameter 1–10(–15) cm. Increase bulbs absent to several, \pm ovoid or of similar shape as the main bulb, often flattened on inner side. Protective bulbcoat-leaves several, papery, smooth, purplish, yellowish, brownish or white; storage leaves few to many. *Foliage leaves* 3–8(–9), erect to suberect, semiterete, fistulose, 10–50 cm by 3–20 mm. *Inflorescence* spherical. *Flowers* subcampanulate to urceolate; tepals greenish to whitish; stamens not or slightly exceeding tepals.

Two more or less distinct cultivar groups are distinguished:

- 1a. Bulbs small, diameter 1–3.5 cm; increase bulbs several; protective bulbcoat-leaves purplish, brownish, or white; plants 0.2–0.5 m, not robust . . . a. Cultivar group **Aggregatum**

- b. Bulbs usually larger, diameter 2–10(–15) cm; increase bulbs absent or only few; protective bulbcoat-leaves light yellow to light brown or brown-purplish; plants 0.6–1.2 m, robust

b. Cultivar group **Common Onion**

a. Cultivar group *Aggregatum*

Allium ascalonicum auct. non L.: Ochse & Bakh., Veget. Dutch East Indies (1931) 441.

Allium cepa L. var. *ascalonicum* Backer, Handb. Fl. Java 3 (1924) 60.

Bulb globose to ovoid, 1.5–4 by 1–3.5 cm. Increase bulbs several, of similar shape as the main bulb. Protective bulbcoat-leaves purplish,

brownish, or white. *Foliage leaves* 10–35(–41) cm by 3–10 mm.

Distribution – Centre of origin in N Africa and E Mediterranean. Primary centre of diversity in the Near East. Shallots are grown in the USA, Europe, Africa, the Caribbean countries, Australia, and Asia.

Common names – Shallot, Multiplier shallot.

b. Cultivar group *Common Onion*

Allium cepa L. var. *typicum* Backer, Handb. Fl. Java 3 (1924) 60.

Bulb depressed globose to ovoid or obovoid, 3–5.5 by 2–10(–15) cm. Increase bulbs usually absent or, in cultivars from India and Burma, few present, \pm ovoid. Protective bulbcoat-leaves light yellow to light brown or brown-purplish. *Foliage leaves* 35–50 cm by 10–20 mm.

Distribution – The onion is not known as a wild species, but in its primary centre of diversity, Central Asia, several related wild species occur. A secondary centre of diversity is the Near East and the Mediterranean, a rich diversity is also found in India.

Common names – Onion, Dry bulb onion.

3. *Allium chinense* G. Don, Mem. Wern. Nat. Hist. Soc. 6 (1827) 83; Mann & Stearn, Econ. Bot. 14 (1960) 69.

Allium exsertum (Lindley) Baker, J. Bot. (London) 12 (1874) 294, non G. Don (1827).

Allium bakeri Regel, Acta Horti Petrop. 3, iii (1875) 341.

Allium schoenoprasum auct. non L.: Heyne, Nutt. Pl. Ned. Indië ed. 2 (1927) 441; Ochse & Bakh., Veget. Dutch East Indies (1931) 455; Backer & Bakh. f., Fl. Java 3 (1968) 130.

Bulbs gregarious, narrowly ovoid, up to 3.5 cm long, diameter 7–15 mm, gradually passing into the leaves. Protective bulbcoat-leaves several, membranous, smooth, white, brownish or purplish. *Foliage leaves* 3–4(–5), prostrate to suberect, 3- or 5-angled in section, 20–40 cm by 1–5 mm. *Inflorescence* umbellate. *Flowers* campanulate; tepals light violet; stamens longly exceeding tepals.

Distribution – Native to C and E China. Cultivated in China, Japan, California, and SE Asia. Carried worldwide as a garden crop by Asian communities.

Note – Vegetative plants of *A. chinense* superficially resemble those of *A. schoenoprasum*. However, the latter species has terete leaves and indistinct bulbs, whereas *A. chinense* has more or less angled leaves and distinct bulbs.

Common name – Rakkyo.

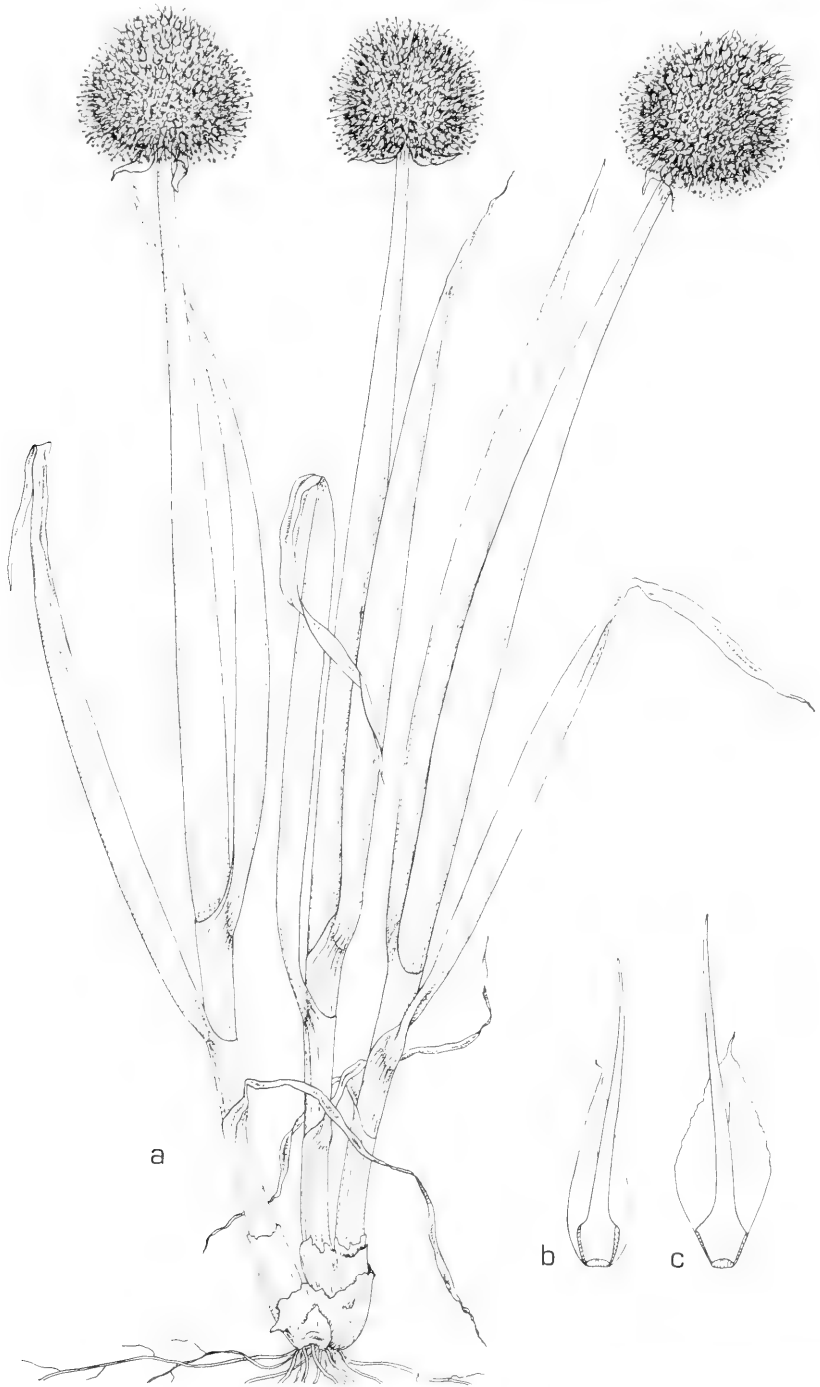


Fig. 1. *Allium fistulosum* L. a. Habit; b, c. outer and inner tepal with corresponding filaments. From: B.E.E. de Wilde-Duyfjes, A revision of the genus *Allium* in Africa [Meded. Landbouwhogeschool Wageningen 76-11 (1976) 88, fig. 15].

4. *Allium fistulosum* L., Sp. Pl. 1 (1753) 301.

Bulb indistinct, oblong to ovoid, 3.5–8 cm long, width 5–25 mm, gradually passing into the leaves. Increase bulbs few to several, narrow and inconspicuous. Protective bulbcoat-leaves several, papery, smooth, brownish, whitish, or purplish. *Foliage leaves* 4–6, erect, terete, fistulose, 20–54 cm by 5–20 mm. *Inflorescence* (hemi)spherical. *Flowers* narrowly campanulate to urceolate; tepals pale yellow; stamens longly exceeding tepals. – **Fig. 1.**

Distribution – Origin in Siberia and China, not known as a wild species. *Allium fistulosum* has been, since prehistoric times, the main garden onion of China and Japan. It is cultivated widely throughout the world, ranging from Siberia to tropical Asia, including China, Japan, Korea, Taiwan, and the SE Asian countries.

Common names – Japanese bunching onion, Welsh onion, Green bunching onion.

Note – *Allium × proliferum* (Moench) Schrad. ex Willd. *Wakegi group*, a hybrid between *A. fistulosum* and *A. cepa* cv. group *Aggregatum*, is cultivated occasionally in Malesia. It has been grown for centuries in China, Japan, and SE Asia [Hanelt in Rabinowitch & Brewster (eds.), *Onions and allied crops* 1 (1990) 18]. This hybrid has characters from both parents. It develops a distinct bulb like the shallot, and terete leaves like *A. fistulosum* but slender and very erect. The flowers are subcampanulate as in *A. cepa*, but the stamens exceed the perianth and the inner filaments are without lateral teeth at the base as in the other parent. The hybrid is completely sterile and does not form fertile seeds.

5. *Allium sativum* L., Sp. Pl. 1 (1753) 297.

Bulb distinct, depressed globose to ovoid, diameter up to c. 7 cm, mainly composed of increase bulbs (cloves). Increase bulbs (1–)4–15, broadly ovoid to ovoid, as long as the main bulb when mature, wrapped in one cartilaginous prophyll. Protective bulbcoat-leaves papery or chartaceous, smooth, whitish or purplish, in young plants fibrous and brown. *Foliage leaves* 4–10, curved, flat, V-shaped in section, 20–50 cm by 10–25 mm. *Inflorescence* subspherical, composed either of only sessile bulbils (topsets) or of bulbils mixed with flowers. *Flowers* usually ill-developed, or rudimentary, or absent; perianth subcampanulate; tepals pale pink or greenish; stamens shorter than tepals.

Distribution – Some consider *A. longicuspis* Regel, endemic to Central Asia, as the wild parent of this cultigen. It was originally grown in Europe and China and nowadays worldwide.

Common name – Garlic.

6. *Allium schoenoprasum* L., Sp. Pl. 1 (1753) 301.

Bulbs gregarious, indistinct, oblong to narrowly ovoid, 1–3 cm long, gradually passing into scape and leaves, several set on a rhizome. Increase bulbs few to several, narrow and inconspicuous. Protective bulbcoat-leaves several, papery, smooth, brownish. *Foliage leaves* 3–6, erect, terete, fistulose, 10–50 cm by 1–5(–7) mm. *Inflorescence* (hemi)spherical. *Flowers* narrowly urceolate; tepals white to purple; stamens much shorter than tepals.

Distribution – This very variable species is known as a wild plant throughout the Northern Hemisphere: Europe, Asia, and North America. It is cultivated worldwide, in Malesia it is grown only occasionally.

Common name – Chive.

Note – *Allium schoenoprasum* is sometimes confused with *A. chinense*, see under the latter species.

7. *Allium tuberosum* Rotler ex Spreng., Caroli Linnaei Syst. Veg. 2 (1825) 38; Stearn, Herbertia 11 (1944) 226.

Allium uliginosum G. Don, Mem. Wern. Nat. Hist. Soc. 6 (1827) 60.

Allium odorum auct. non L.: Heyne, Nutt. Pl. Ned. Indië ed. 2 (1927) 441; Ochse & Bakh., Veget. Dutch East Indies (1931) 450; Backer & Bakh. f., Fl. Java 3 (1968) 131.

Allium bakeri auct. non Regel: Backer & Bakh. f., Fl. Java 3 (1968) 131.

Bulb indistinct, narrowly ovoid to ovoid, 15–20 by c. 15 mm, several set on a rhizome. Protective bulbcoat-leaves several, broken up into netted fibres, light brown to brown. *Foliage leaves* 4–9, suberect or curved, flat, slightly rounded or keeled on lower surface, 13–45 cm by 2–10 mm. *Inflorescence* umbellate. *Flowers* stellate; tepals white; stamens ± equalling tepals.

Distribution – The primary centre of origin is unknown, as this species easily runs wild. Known as a wild species in eastern Asia. Cultivation from E Mongolia to Japan, the Philippines, Indonesia, Malaysia and through Thailand to N India.

Common name – Chinese chive.

Note – Sometimes sub-naturalized.

NOTHOSCORDUM

Nothoscordum Kunth, Enum. Pl. 4 (1843) 457, nom. gen. cons.

Nothoscordum inodorum (Aiton) G. Nichols, Ill. Dict. Gard. 2 (1885/89) 457; Backer & Bakh. f., Fl. Java 3 (1968) 132; Jessop in Fl. Males. I, 9¹ (1979) 234.

Glabrous, inodorous herb with bulbs. *Leaves* radical, linear, flat, 15–45 cm by 5–12 mm. *Umbels* on up to 70 cm long peduncle, 6–17-flowered. *Tepals* 6, shortly connate at base, white, sometimes with a purple median streak. *Stamens* 6, inserted on the base of the perianth; filaments ligulate. *Ovary* with many ovules per locule. *Fruit* a capsule, loculicidally 3-valved. Seeds several, black.

Distribution – Native to subtropical North America; cultivated as an ornamental, often escaped and naturalized. In Java sometimes cultivated, locally naturalized in W Java (Backer & Bakh. f., l.c.).

Habitat & Ecology – Sometimes gregarious in fields, tea-gardens, and along roadsides, altitude 1000–1500 m. Fl.: Jan.–Dec. Easily propagated by bulbils and seeds, difficult to eradicate.

Note – The species was mentioned by Jessop (l.c.) in the Flora Malesiana treatment of *Liliaceae*, in which treatment the cultivated vegetables and condiments were ignored.

CORIARIACEAE

(Brigitta E. E. Duyfjes, Leiden, The Netherlands)

CORIARIA

Coriaria L., Sp. Pl. ed. 1 (1753) 1037. — Lectotype species: *Coriaria myrtifolia* L.

Shrubs (rarely perennial herbs with herbaceous stems) or small *trees*. *Roots* with nodules with nitrogen fixing bacteria. Innovations in flushes from perulate apical buds. Branches 4-angular, ridges alternating; xylem with broad medullary rays. *Leaves* generally small, sessile or subsessile, with a narrow joint at base, simple, entire, cordate-ovate to lanceolate, acute, decussate, or (not in Malesia) in whorls, phyllotaxis of the lateral branches mostly showing as pseudo-distichous; blades palmately 3–9-curvi-nerved, net-veined, those sustaining side-branches often of somewhat different shape. Stipules absent (but see note). *Racemes* terminal or axillary. Flowers in the axils of small bracts, greenish or reddish, actinomorphic, hypogynous, polygamous, i.e., bisexual or functionally unisexual (both male and female flowers with rudiments of the other sex). Pedicel slender, bracteoles absent. Perianth 5-merous; sepals 5, imbricate, persistent, ovate; petals 5, alternate, shorter than the sepals, keeled inside, accrescent, becoming more or less fleshy, each enveloping a carpel in fruit. *Stamens* 10, in two whorls, free, or those opposite the petals adnate to the keel of the petal; filaments filiform; anthers exerted, ellipsoid or sagittate, papillose or smooth, 2-celled, opening lengthwise. Carpels 5–10(–12), free, one-celled, the basal part adnate to a central conical receptacle, each with a slender distinct papillose style. Ovules one per carpel, pendulous, anatropous, with the micropyle directed upwards. *Pseudo-fruit* consisting of hard-walled, laterally compressed achenes, more or less enclosed by the fleshy-accescent petals, each achene subtended on each side by half of the adjoining petal. *Seed* compressed, without an aril, testa thin, endosperm scanty or none; embryo straight. — **Fig. 1.**

Distribution — About 20 species, depending on the taxonomic treatment (see infrageneric variation), with a much broken distribution: the West-Mediterranean, the Himalayan Region from Pakistan to SE Asia, and E Asia (Japan, China, incl. Hainan), through Malesia (rare) to New Zealand (and the Subantarctic Islands), Chile, Peru as far North as Mexico; in *Malesia*: the Philippines (Luzon) and Papua New Guinea.

Habitat & Ecology — In Malesia and SE Asia in the submontane and montane zone, often pioneering in exposed situations. Apparently a genus of temperate and subtropical climatic conditions. There are remarkable disjunctions in the distribution. The flowers, with exerted slender stamens and styles, are adapted to wind pollination. The fleshy pericarp suggests dispersal by animals, presumably birds. The racemes and fruits have a superficial resemblance with the *Phytolaccaceae*.

Systematic position of the family — This monogeneric family has been the subject of various studies in an attempt to settle its phylogenetic and systematic position. It has no close relationship to any suggested family. Its distribution and the numerous proposed putative alliances give the impression of an old genus; it is also found as a fossil (see the chapter on palynology). Possibly the status of a separate order *Coriariales* for this single isolated genus is a good solution.

References: Bohm, B. A. & R. Ornduff, *Syst. Bot.* 6 (1981) 15–26. — Carlquist, S., *Syst. Bot.* 10 (1985) 174–183. — Cronquist, A., *An integrated system of classification of flowering plants* (1981) 136–139; *The evolution and classification of flowering plants* (1988) 289, 504. — Engler, A., in Engler & Prantl, *Nat. Pflanzenfam.* III, 5 (1896) 128–129. — Garg, M., *Phytomorphology* 30 (1980) 15–26. — Hutchinson, J., *Families of flowering plants* (1926) 156; *ibid.*, ed. 3 (1973) 136, 183–184. — Oginuma, K., M. Nakata, M. Suzuki, & H. Tobe, *Bot. Mag. Tokyo* 104 (1991) 297–308. — Takhtajan, A., *Evolution und Ausbreitung der Blütenpflanzen* (1973) 173; *Bot. Rev.* 46 (1980) 225–259; *Floristic regions of the world* (1988) 334.

Infrageneric variation — Because of the great variation within populations of *Coriaria*, the generally weak demarcation of species described and the occurrence of natural hybridization, especially apparent in New Zealand, Skog (1972) distinguished only five species in total for the whole genus. One of these is the aggregate species *C. ruscifolia* L., comprising all species from South and Central America, the South Pacific islands, New Zealand and New Guinea. *Coriaria ruscifolia* has two subspecies, subsp. *ruscifolia* and subsp. *microphylla*, the latter including *C. papuana* from New Guinea. Following Skog, our present *C. intermedia* would be included in *C. japonica*. To the contrary, a recent karyomorphological study (Oginuma et al. 1991) provides evidence for distinguishing at least four species in *C. ruscifolia* sensu Skog. For convenience sake, two locally well-characterized species are accepted here for Malesia, *C. intermedia* and *C. papuana*.

References: Oginuma, K., M. Nakata, M. Suzuki & H. Tobe, *Bot. Mag. Tokyo* 104 (1991) 297–308. — Skog, L. E., *Rhodora* 74 (1972) 242–253.

Vegetative Anatomy — *Leaf anatomy.* Cuticle striated; stomata paracytic; lamina dorsiventral; midrib with single collateral vascular strand supported by weakly developed sclerenchyma caps.

Wood anatomy. Wood weakly semi-ring-porous or diffuse-porous. Vessels angular, thin-walled, in multiples and small clusters, rarely solitary, with simple perforations and alternate intervessel pits with slit-like, occasionally coalescent apertures. Vascular tracheids, resembling narrow vessel elements, present in association with vessel groups. Ground tissue composed of libriform fibres. Parenchyma vasicentric to confluent, fusiform or in 2(–4)-celled strands. Rays multiseriate, broad and tall, composed predominantly of erect and square cells, integrading with procumbent cells. Crystals present in some ray cells. Vessel elements, axial parenchyma, and sometimes also the fibres storied.

Carlquist (1985) concluded that the affinities of *Coriaria* remain elusive, despite some wood anatomical similarities with *Corynocarpus*, woody *Ranunculaceae*, and several *Simaroubaceae*.

References: Carlquist, S., Syst. Bot. 10 (1985) 174–183 (wood anatomy of *Coriaria arborea*, *C. japonica*, *C. ruscifolia* and *C. thymifolia*) — Metcalfe, C.R. & L. Chalk, Anatomy of the Dicotyledons (1950) — Santos, J.K., Philipp. J. Sc. 46 (1931) 257–266 (leaf anatomy of *Coriaria intermedia*). — Suzuki, M. & K. Yoda, J. Jap. Bot. 61 (1986) 289–296, 333–341 (wood anatomy of *Coriaria terminalis*, *C. japonica*, *C. nepalensis* and *C. intermedia*). — Yoda, K. & M. Suzuki, Bot. Mag. Tokyo 105 (1992) 235–245 (wood anatomy of 14 species, including also *Coriaria intermedia*).

P. Baas

Chromosomes — The basic chromosome number is $x = 20$; the somatic chromosome number is for the majority of species, including the Malesian representatives, $2n = 40$, but outside Malesia tetraploidy ($2n = 80$) also occurs.

Reference: Oginuma, K., M. Nakata, M. Suzuki, & H. Tobe, Bot. Mag. Tokyo 104 (1991) 297–308.

Palynology — *Coriaria* pollen is small to medium-sized (polar axis 14–35 μm , equatorial diameter 20–34 μm), isopolar, usually suboblate (P/E 0.75–0.88) and 3-aperturate, either colporate or pororate. The equatorial outline is (sub)circular, the meridional outline elliptic. The colpi have an ectocolpus of 4–10 by 0.5–2 μm and a longitudinal endoporus of 2–5 by 3–8 μm . Pororate grains have isodiametric ectopori of 2–4 μm , often with thickened protruding margins, and longitudinal to isodiametric endopori of 3–5 by 4–6 μm . The exine is 0.75–1.5 μm thick and distinctly stratified, showing a nexine columellate infratectal layer and a tectum, which are about equally thick. The tectum has a scabrate ornamentation consisting of c. 0.2 μm high conical elements and shows many small funnel-shaped perforations. Individual columellae, scabrae and perforations are usually not distinguishable with light microscopy.

Pragłowski (1970) studied the pollen of 16 species. He recognised a group with colporate pollen (12 species from America, the Mediterranean region, China, New Guinea and New Zealand) and a group with pororate pollen (4 species from India, China, Japan, Taiwan and Luzon). The colporate *C. terminalis* from China is intermediate, having rather short ectocolpi (3–5 μm).

Skog (1972) distinguished only 5 species in *Coriaria*: *C. ruscifolia* (including all material from America, New Guinea, New Zealand and other Pacific islands) has colporate pollen; *C. terminalis* (Tibet, China) and *C. myrtifolia* (Mediterranean region) are two other colporate species; *C. nepalensis* (including *C. sinica*; India, Nepal, China) and *C. japonica* (including *C. intermedia*; Japan, Taiwan, Luzon) have pororate pollen.

Pollen morphology does not elucidate the phylogenetic position of *Coriaria*. *Coriaria* pollen has been tentatively compared with that of *Sapindaceae* (Meenakshi Garg 1980), but obviously the available data of the latter did not represent adequate reference material. *Coriaria* pollen is relatively ‘simple’, and does not show special features that allow affiliation with other taxa. It resembles pollen of *Corylus* (*Betulaceae*) and *Myrica* (*Myricaceae*). However, this resemblance may be explained from the anemophilous pollination system shared by these plants.

Fossil *Coriaria* pollen has been reported from the upper Miocene of Spain, the Pliocene of New Zealand (see Muller 1981) and the Pleistocene of the Netherlands (see Pragłowski, l.c.).

References: Meenakshi Garg, *Phytomorphology* 30 (1980) 5–10. — Muller, J., *Bot. Review* 47 (1981) 1–142. — Praglowski, J., *World Pollen Flora* 1 (1970) 15–22, 25–31. — Skog, L.E., *Rhodora* 74 (1972) 242–253.

R.W.J.M. Van Der Ham

Phytochemistry — The monogeneric family has its name from the Latin *corium* (= leather) because leaves and twigs of the Mediterranean *Coriaria myrtifolia* were formerly used in tannery. Chemical characters of *Coriariaceae* were summarized by Hegnauer (1964, 1989), where many references to phytochemical and toxicological literature are available. The phytochemistry of this small family is surprisingly well known. All species seem to contain bitter, toxic lactones and to produce large amounts of ellagitannins accompanied by lesser amounts of precursor gallotannins.

The toxic, lactonic principles are picrotaxan-type sesquiterpenes. Coriamyrtin, corianin, tutin (from the Maori name 'Tutu' of the genus), and pseudotutin are the toxic picrotoxin-like compounds of *Coriaria*. All *Coriaria* species are known to be toxic. The picrotaxans are a group of convulsive, insecticidal and ichthyotoxic natural products which occur erratically in angiosperms (also known from a few genera of *Menispermaceae*, *Euphorbiaceae*, *Orchidaceae*).

The ellagitannins of *Coriaria japonica* were studied thoroughly by Okuda's group (Okuda et al. 1990, 1993). Monomeric ellagitannins like tellimagrandin-I and -II, coriariin-B and -F and geraniin and dimeric ellagitannins like coriariin-A and -C to -E, and rugosin-D and -E are produced by this taxon which also contains trigalloylglucose.

Glycosides of the flavonols kaempferol and quercetin are present in leaves of all species which have been investigated. They are accompanied in most species by the 7-glucoside of the flavanone naringenin.

Fruits, leaves and twigs of the South American species *C. ruscifolia* yielded the triterpenic acid ursolic acid and phytosterins and coriamyrtin.

The carbohydrate metabolism of the family shows special features. A new heptulose, coriose, was isolated from roots, stems, leaves, fruits and seeds of *C. japonica*; it is accompanied by sedoheptulose in leaves and by a corresponding heptitol, volemitol, in seeds. Coriose and another heptulose are also present in *C. intermedia*, *nepalensis*, *ruscifolia* and *thymifolia*. Myo-inositol is also present in easily detectable amounts in all parts of *C. japonica*.

Seeds contain much fatty oil (up to 70% of kernels) with an unusual fatty acid, coriolic acid, as the main fatty acid. Coriolic acid is 9-*cis*,11-*trans*-13-hydroxyoctadecadienoic acid; this acid can be interpreted as a monohydrated α -elaeostearic acid. Seed oils of all investigated species, *C. myrtifolia*, *nepalensis*, *papuana*, *ruscifolia*, *sarmentosa* and *terminalis*, contained this new fatty acid.

On account of its chemistry the family must belong to the core of dicotyledons which produce and accumulate ellagitannins.

Phytochemistry suggests *Euphorbiaceae* on the one side and *Crassulaceae-Saxifragaceae* s. str. on the other side as good candidates for remote relatives. Thorne (1992) classifies *Coriariaceae* in *Rutanae* in the most recent version of his phylogenetic system of angiosperms and Huber (1991) suggests close relationship with *Anacardiaceae*.

References: Huber, H., Angiospermen. Leitfaden durch die Ordnungen und Familien der Bedecktsamer (1991), G. Fischer, Stuttgart. — Okuda, T., et al., *Heterocycles* 30 (1990) 1195 (review of oligomeric hydrolysable tannins; a new class of plant polyphenols). — Okuda, T., et al., *Phytochemistry* 32 (1993) 507 (classification and distribution in dicotyledons of oligomeric hydrolysable tannins). — Thorne, R.F., Classification and geography of the flowering plants, *Bot. Rev.* 58 (1992) 225–348.

R. Hegnauer

Uses — Rich in tannin, used locally for tanning and black-dye. The flowers and fruits contain a narcotic, poisonous substance, coriariin. Some *Coriaria* species (e.g. the Mediterranean *C. myrtifolia* L., some New Zealand species, and also *C. papuana*) possess root nodules with nitrogen-fixing properties. As these species often grow in pioneering situations, such as lava fields and roadsides, they may have a place in planting programmes for erosion control in wet scree country (Daly et al. 1972). *Coriaria nepalensis* (India) is one of the food plants of the silk moth.

References: Ambasta (ed.), Useful plants of India (1986) 142. — Daly, G.T., B.E. Smith & S. Chua, *Proc. New Zeal. Ecol. Soc.* 19 (1972) 65–74. — Watt, G., The commercial products of India (1908) 1012.

Note — In and beside the leaf-axils numerous minute, fleshy, finger-shaped, and gland-like emergentia are usually present. These have been called stipules by various authors.

KEY TO THE SPECIES

- 1a. Racemes 4–10 cm long, axillary, aggregated in groups of (1 or) 2 or 3, subtended by small cataphylls. Flowers c. 5 mm across. Leaves oblong, 5–7 cm long, 3-nerved. Fruits c. 5 mm across **1. *C. intermedia***
- b. Racemes (7–)20 cm long, axillary, solitary. Flowers c. 2.5 mm across. Leaves ovate-oblong, 1.5–4 cm long, 5–7(–11)-nerved. Fruits 2–3 mm across **2. *C. papuana***

1. *Coriaria intermedia* Matsumura, *Bot. Mag. Tokyo, Bot. Soc.* 12 (1898) 62; Hui-Lin Li, *Woody Fl. Taiwan* (1963) 443; in *Fl. Taiwan* 3 (1977) 563, pl. 729; Kanehira, *Formos. Trees*, rev. ed. (1936) 361, f. 317; Keng, *Orders and families of seedplants of Taiwan* (1987) 62, f. 20.1; Merr., *Enum. Philipp. Flow. Pl.* 4 (1926) 88. — Types: *Tashiro s.n.* (not seen), *Owatori s.n.* (not seen), both from Taiwan.

Shrubs or small trees, 1–3 m high. Roots forming nodules. Leaves decussate; petioles c. 2 mm long; blades oblong (or ovate), glabrous, 3-nerved, midrib pinkish, (3–)5–7 by 1.5–2.5 cm, base cuneate, apex acute. Inflorescences consisting of subaxillary fascicles of 1–3 racemes, 4–10 cm long, glabrous; bracts ovate, glabrous, 4.5–5 by 2.5–4 mm, acute or blunt, the margins irregularly serrate. Flowers bisexual or unisexual, yellowish green; pedicels 2–7 mm long. *Male flowers:* sepals

broadly ovate, c. 3.2 by 2.4 mm, obtuse; petals ovate, c. 1.2 by 0.5 mm, acute; stamens c. 8 mm long, filaments c. 6 mm long, anthers 1.5–2 by c. 0.8 mm, papillose. *Female flowers:* sepals broadly ovate, c. 3 by 2 mm, obtuse, or acute; petals ovate, c. 2.8 by 1.8 mm, acute; styles c. 3.5 mm long; carpels 5, c. 1.5 by 1 mm. *Pseudo-fruit* 3–5 mm across; achenes 2.8–3 by 1.5–1.8 mm, glabrous, with a few longitudinal ribs.

Distribution — Taiwan; in *Malesia*: Philippines (N Luzon).

Habitat & Ecology — Thickets, open forests, sunny and stony slopes, dry riverbeds and watercourses, from low altitudes up to c. 2400 m.

Notes — Closely allied to *C. japonica*.

Due to its occurrence in riverbeds and watercourses, *C. intermedia* is possibly a facultative rheophyte, but it was not recognized as such by Van Steenis (1981); see also under *C. papuana*.

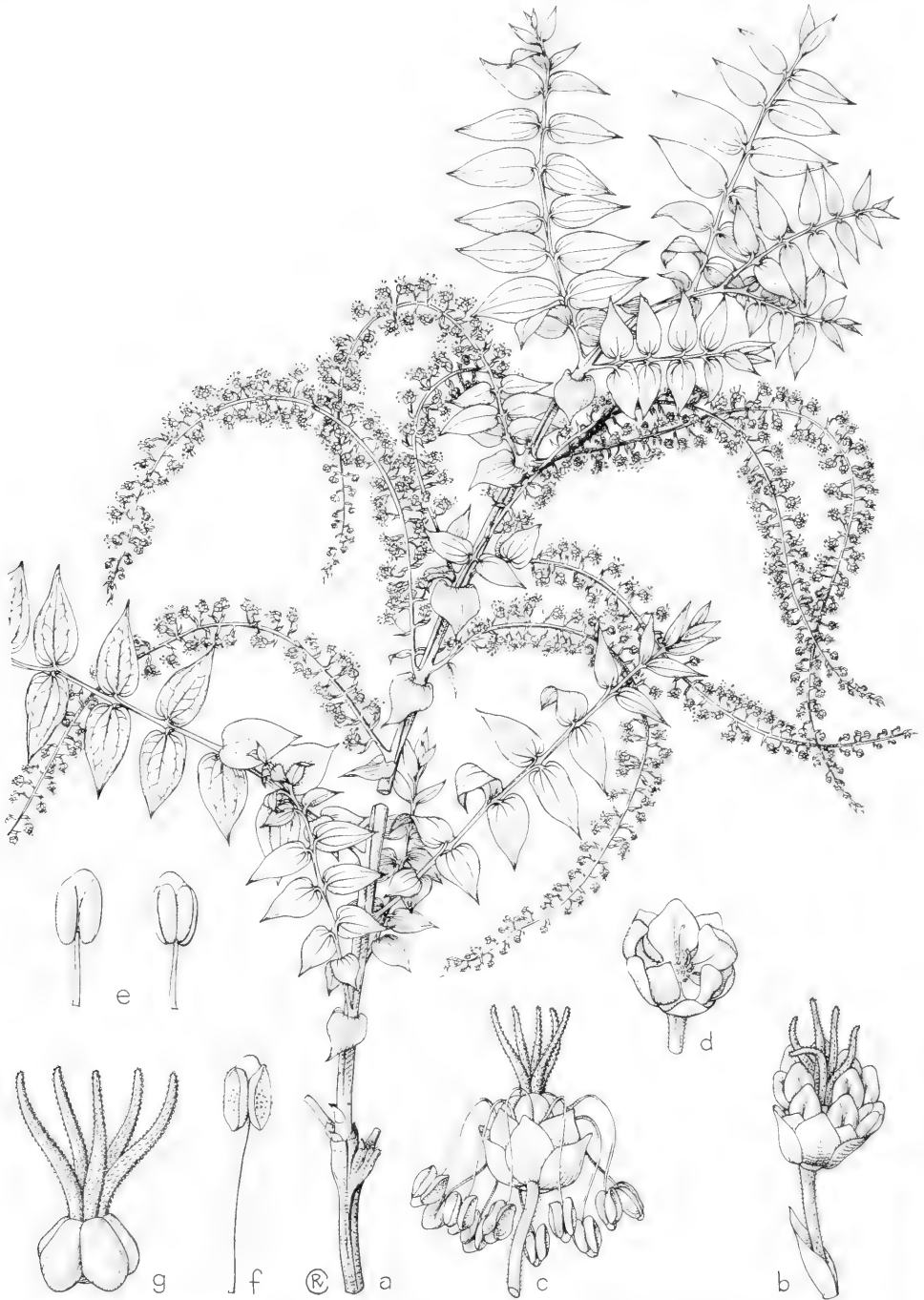


Fig. 1. *Coriaria papuana* Warburg. a. Portion of branch and apical part of branch with inflorescences, $\times 0.6$; b, c. flowers, young and in anthesis, $\times 6$; d. perianth, stamens and pistil removed, $\times 6$; e, f. immature and mature stamens, $\times 10$; g. pistil, $\times 10$ (drawn by R. van Crevel after a specimen collected by Gyldenstolpe in herb. S).

According to Hui-Lin Li (1963, 1977) the roots and seeds are very poisonous. Keng (1987) mentioned that the species is used in local medicine.

Bisexual and unisexual flowers: in the studied material, besides bisexual flowers with normal looking stamens and pistils, only unisexual male flowers were present, i.e. flowers with well-developed stamens, destitute of pistillodes; unisexual female flowers have never been seen. Most flowers had already developed pseudo-fruits with persisting withered stamens.

2. *Coriaria papuana* Warb., Bot. Jahrb. 16 (1893) 22, f. 741; P. van Royen, Alpine Flora New Guinea 4 (1983) 2547; Steenis, Rheophytes of the World (1981) 219. — Type: *Hellwig 364* (B, lost); neotype: *van Royen 16242* (L).

Spreading and much branched bushy shrubs or small trees 0.5–4 m high; young flushes tinged reddish. Root system extensive and forming nodules. *Leaves* decussate, subsessile, ovate-oblong, base rounded to cordate, apex acute; (1–)1.5–4 by 0.8–1.7 cm, glabrous, except nerves on both surfaces with short white hairs; nerves 3–5; leaves at the base of lateral twigs and inflorescences smaller, cordate, up to 11-nerved. *Inflorescences* consisting

of solitary axillary racemes 7–20 cm long, rachis and pedicels densely beset with short white hairs; bracts ovate to lanceolate, 2–3 mm long, shortly acuminate, glabrous or scabrous on the lower surface, margin irregularly serrate. *Flowers* bisexual, dark red, pink or yellow-green; pedicels 3–7 mm long; sepals broadly ovate, 1.5–2 by 1–1.2 mm, acute; petals broadly ovate, 1–1.8 by 1–1.5 mm, acute. *Stamens* 2–3 mm long; filaments filiform, 0.5–1 mm long; anthers ellipsoid, 1–1.2 mm long, papillose. *Carpels* 5, c. 0.8 by 0.4–0.8 mm; styles c. 3 mm long. *Pseudo-fruits* 2–3 mm across, red, dark purple or blackish, soft when ripe; achenes c. 1.5 by 1.2 mm, glabrous, with a few longitudinal vein-like ribs. — **Fig. 1.**

Distribution — *Malesia*: endemic to Papua New Guinea: Western Highlands (Chimbu), Eastern Highlands, Morobe Prov. (Finisterre Mts, Mt Dickson area).

Habitat & Ecology — Alongside and in stony and rocky riverbeds, on foothills and in upper montane forest; altitude 600–3500 m. Frequently growing gregariously as a pioneer in exposed places like ridges and landslides.

Note — Because of the enormous root-system and the preference for growing in riverbeds, the species was listed as a facultative rheophyte by Van Steenis (1981).

PENTASTEMONACEAE

(Brigitta E. E. Duyfjes, Leiden, The Netherlands)

The taxonomic position and rank of the only genus *Pentastemona* has been under discussion since Van Steenis (1982) described the genus in the *Stemonaceae*. Dahlgren et al. (1985) found it highly distinctive and suggested it worthy of family rank. Later on more material of *P. sumatrana* and *P. egregia* has become available facilitating a more accurate description of the androgynoeceum. Conspicuous differences from the *Stemonaceae*, viz. the inferior ovary, the five pouches caused by the fusion of connectives and stigma (especially well-developed in *P. egregia*), the berry-like fruit and the exotesta (sarcotesta) of the seed, warranted the distinction of a separate new family for the genus.

Note — *Pentastemona* is the first genus in the Monocotyledons with normally regular 5-merous flowers. Checked on abundant material, occasional flowers with 4 or 6 perianth lobes and stamens occur in both species.

References: Dahlgren, R.M.T., H.T. Clifford & P.F. Yeo, The families of the Monocotyledons (1985) 123. — Duyfjes, B.E.E., *Blumea* 36 (1991) 239–252; *ibid.*, 36 (1992) 551–552 (family description). — Steenis, C.G.G.J. van, *Blumea* 28 (1982) 151–163, f. 1.

PENTASTEMONA

Pentastemona Steenis, *Blumea* 28 (1982) 160. — Type: *Pentastemona sumatrana* Steenis.

Low juicy herbs with a short, unbranched, largely overground green rhizome with pale roots; stem curving up into a short erect portion bearing several leaves, leaving thin, almost ring-shaped scars; plants almost glabrous or with sparse uniseriate hairs. *Leaves* papyraceous when dry; blade ovate, with 6–8 pairs of arching basal and suprabasal nerves, shallowly depressed above, secondary intervenation fine-trabeculate, margin entire; petiole long, towards the base canaliculate and shortly sheathing, with the edge hyaline and fringed-hairy. *Inflorescences* axillary, either short-peduncled simple racemes or long-peduncled compound racemes; flowers and bracts dotted with raphides, bracteoles absent. *Flowers* with one kind of perianth, 5-merous; *tepals* free or partly united, imbricate, outside papillose, persisting in fruit. *Stamens* epitepalous; filaments apparently absent since they are completely united into a conspicuous fleshy ring, which is either free or partly fused to the base of the fleshy flower tube, which, together with the juicy-fleshy torus and the stigma, form a solid hypanthium with a flat or concave top; anthers, consisting of two short, broadly ovate thecae, each opening by a longitudinal lateral slit. The thecae are sessile, laterally directed and separated by broad fleshy connectives, which taper into slender or broad inward-curved appendices, the tips of which are fused with the stigma; the stamens and stigma thus form 5 pouches in the fleshy hypanthium, each containing two thecae, one from each of the adjacent anthers. Viewed from above, the appearance is as if the anthers are alternitepalous (*P. egregia*), or anthers shortly protruding

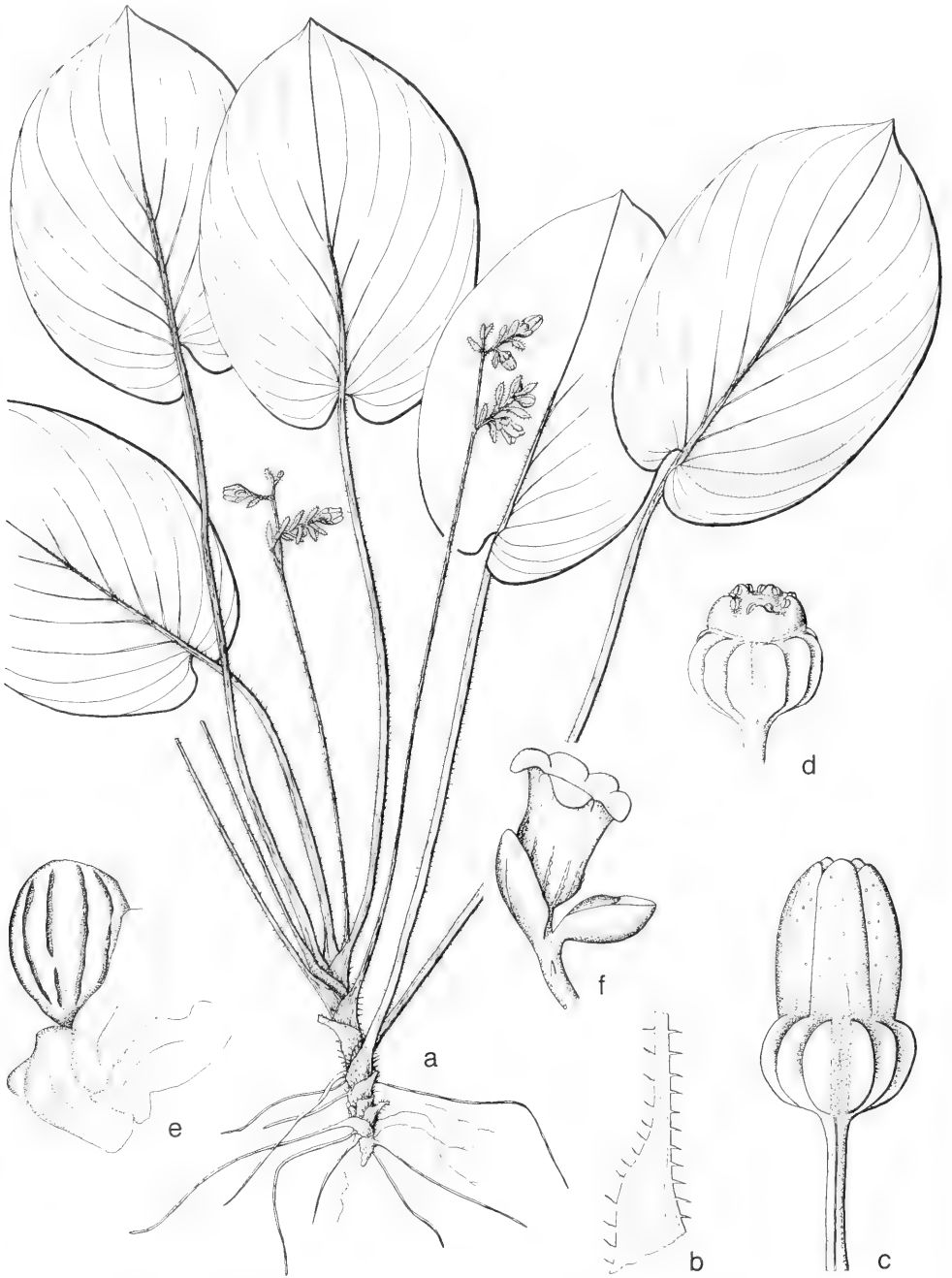


Fig. 1. *Pentastemona sumatrana* Steenis. a. Habit, $\times 0.5$; b. base of leaf sheath, $\times 1.5$; c. flower, $\times 6$; d. flower, tepals removed, $\times 6$; e. ribbed seed, sarcotesta torn away, $\times 25$. — *P. egregia* (Schott) Steenis. f. Flower, $\times 2$ (a–e: de Wilde & de Wilde-Duyffjes 18695; f: Meijer 17010).

(*P. sumatrana*). Ovary inferior, one-celled, ovules numerous on three inward projecting longitudinally furrowed, parietal placentas; style short and inconspicuous, stigma broad, flatish, entire or 3- or 4-lobed, papillose. Fruit berry-like, sharply longitudinally 10-ridged, the perianth persisting. Seeds many, with a collar-like undulate aril covering about one third of the seed; exotesta (sarcotesta) transparent; pericarp strongly ribbed; endosperm large; embryo small. — **Figs. 1–3.**

Distribution — *Malesia*: the genus is locally endemic to N and W Central Sumatra, with 2 species.

Habitat & Ecology — Gregarious but very local. In damp places on rocks in rain forest of lowland and hills and apparently often more or less kremnophytic. The berry-like fruit probably decays, by which the seeds become free. When a mature fruit of *P. sumatrana* is opened, the seeds, with their ribbed endocarps, lie in a jelly-like mass of the arils and exotestas, appearing as one coherent mass and suggesting an as yet unknown mode of dispersal.

Pentastemona sumatrana may produce young plants at the top of the inflorescences in a viviparous manner, while in *P. egregia* young plants easily sprout from the margins of broken leaves in their natural habitat. Under damp hothouse conditions *P. egregia* can be propagated in this way.

There are indications that the family possibly is dioecious. The collection *de Wilde 20113* of *P. sumatrana* contains solely female flowers and fruits with ripe seeds; the anthers, although present, appeared to be empty. The collection *Bogner 1724* of *P. egregia* bears functionally male flowers, the anthers of which contain good pollen. Ovaries are also present in these flowers, but are not well-developed and probably contain abortive ovules.

According to Van Steenis (1982) the smallish deep pouches in the receptacle, as in *P. egregia*, suggest nectarial structures, but microscopical examination proved that such structures are absent.

Although gregarious in their natural habitat, the plants themselves are not conspicuous and may have escaped the attention of collectors. This may be a reason for their late discovery.

Floral morphology — The androecium shows a corona-like development of the basal staminal region like that in *Peliosanthes* (*Liliaceae/Convallariaceae*). The late differentiation of the stamens into extensions that contact the stigma, as well as the inferior position of the ovary, suggest a relationship with *Trichopus* (*Trichopodaceae*) and *Stenomeris* (*Stenomeridaceae*).

Reference: Heel, W. A. van, *Blumea* 36 (1992) 481–499, pl. 6, 7.

Seed — The seed shows a remarkable character, viz., a distinct, proportionally thick exotesta (sarcotesta) which in dried condition is only little visible. For the description of ovules and seeds, see Bouman & Deventer (1992).

Reference: Bouman, F. & N. Deventer, *Blumea* 36 (1992) 501–514, pl. 1, 2.

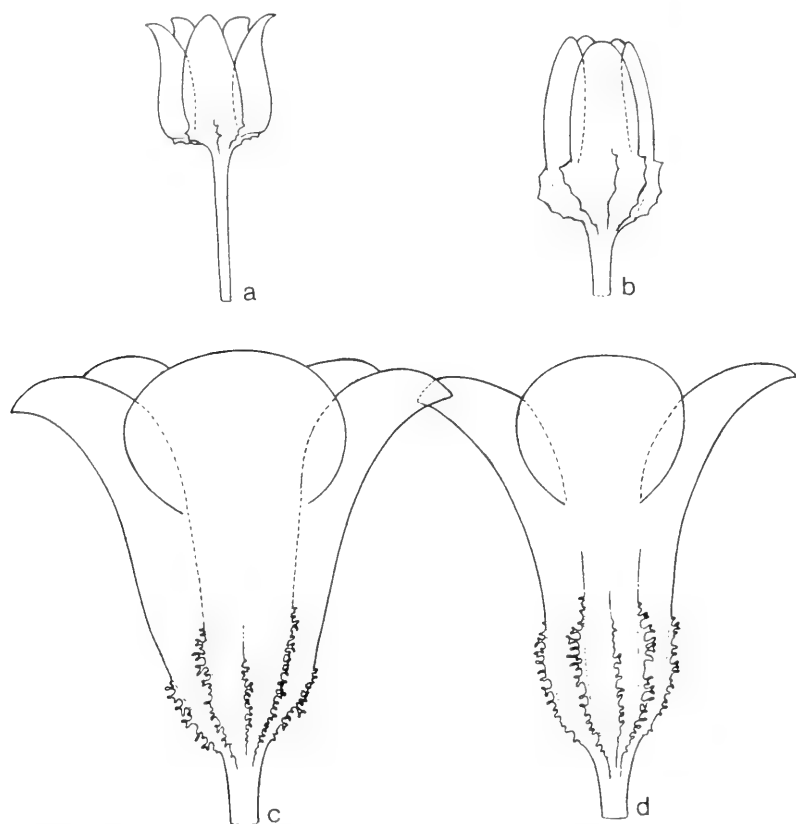


Fig. 2. *Pentastemona*, lateral views of mature flowers. a, b. *P. sumatrana* Steenis, male and female flower respectively; c, d. *P. egregia* (Schott) Steenis, ditto; all $\times 4$ (a, b: de Wilde & de Wilde-Duyfjes 21399; c: Bogner 1724; d: Meijer 17010).

Anatomy — Leaf epidermis anticlinal cell walls straight; stomatal complex tetracytic to cyclocytic; crystals present as abundant styloids and raphides, also as minute, irregularly shaped, solitary crystals. Minute druses have been found throughout the mesophyl. For comparison with *Stemonaceae*, see there (p. 400).

Reference: Baas, P., in C.G.G.J. van Steenis, *Blumea* 28 (1982) 159.

Palynology — *Pentastemona* pollen is small-sized (13–23 μm) and ellipsoidal to spheroidal. The grains are inaperturate, but the intine shows a thick oncus, which limits the exit of the pollen tube at germination. The exine is intectate; exine thickness is c. 0.6 μm throughout (nexine 1/3 to 1/2 of the sexine). The sexine consists of more or less densely arranged composite scabrae of 0.3 to 0.5 μm in diameter, in *P. sumatrana* sometimes in a fossulate pattern. These scabrae are much like the Ubisch bodies on the anther wall. Similar exine ornamentation as well as resemblance to Ubisch bodies was found in *Peliosanthes teta* (*Convallariaceae*).

Pollen of *Pentastemona* is different from that of *Stemonaceae* in being intectate and small (av. 16 μm versus 29, 28 and 27 μm in *Croomia*, *Stemona* and *Stichoneuron*, respectively). In terms of pollen morphology, the *Pentastemonaceae* and *Stemonaceae* do not show any affinity.

References: Ham, R.W.J.M. van der, Blumea 36 (1991) 127–159. — Steenis, C.G.G.J. van, Blumea 28 (1982) 159.

R.W.J.M. van der Ham

Chromosome number — $2n = 14$ (*P. egregia*).

Reference: Duyfjes, B.E.E., Blumea 36 (1991) 242.

Note — The descriptions of both species given below have been largely made on living material and material preserved in alcohol.

KEY TO THE SPECIES

- 1a. Inflorescence compound, as long as or exceeding the petiole; flowers 3–5 mm long, tepals free **2. *P. sumatrana***
- b. Inflorescences simple, generally shorter than the petiole; flowers 10–15 mm long, tepals partly united into a tube **1. *P. egregia***

1. *Pentastemona egregia* (Schott) Steenis, Blumea 28 (1982) 162; Meijer & Bogner, Nature Malaysiana 8, 1 (1983) 26; Hotta, Rep. 1987/1988 Sumatra Research (1989), pl. 7, lower left; Duyfjes, Blumea 36 (1991) 245, f. 2, 3. — *Cryptocoryne egregia* Schott in Miq., Ann. Mus. Bot. Lugd.-Bat. 1 (1863) 122. — Type: *Korthals s.n.*, West Sumatra (L, sh. 898–88.409).

Plants almost glabrous, up to 25 cm; stem terete, 5–10 cm long, c. 1 cm diameter. *Leafblade* ovate to broad-ovate, base shallowly emarginate to cordate, apex short or distinctly acute-acuminate, 7–17 by 5–10 cm; petiole 4–6(–15) cm long. *Inflorescences* shortly peduncled, simple, pauciflorous racemes, hidden under the leaves, 2–5 cm long, after flowering bent towards the ground; bracts ovate, 5–12 mm long, leaf-like, one-nerved, the nerve smooth or with antler-like branched emergences, margin translucent and irregularly undulate. *Flowers* campanulate-urceolate, 12–20 mm long, 18–20 mm diameter; pedicels 3–4 mm long; perianth rather thickly fleshy, connate for slightly over half of its length, pale greenish yellow, tube 6–12 mm long, c. 10 mm wide, lobes roundish, 6–9 mm long, spreading and somewhat recurved in anthesis. *Staminal ring* fused with the basal part of the perianth tube and the hypanthium; outgrowths of the connectives

narrow and somewhat bent down towards the stigma; *ovary* dentately ribbed, shorter than the perianth, c. 5 mm high, the ribs extending on the perianth-tube; stigma flattish, 3- or 4-lobed. *Fruit* c. 13 mm long, with 10 firm ribs fringed with antler-like emergences which extend on the persisting perianth. *Seeds* many, almost globular, c. 1.5 by 1.25 mm, glossy. — **Figs. 1f, 2c, d.**

Distribution — *Malesia*: Central West Sumatra, very local.

Habitat & Ecology — On steep shady slopes in primary forest, up to 500 m altitude.

2. *Pentastemona sumatrana* Steenis, Blumea 28 (1982) 161; Duyfjes, Blumea 36 (1991) 245, f. 2, 3. — Type: *de Wilde & de Wilde-Duyfjes 18695*, N Sumatra (L).

Herbs to 40 cm tall, with scattered hairs; stem short, up to 5 cm. *Leafblade* broad-ovate, base deeply cordate, apex acute, 9–16 by 6–9 cm, upper surface glabrous, lower surface hairy on the nerves; petiole hairy, 6–20 cm long. *Inflorescence* compound, with (1 or) 2–4 densely flowered, raceme-like branches; bracts ovate-lanceolate, green, 3–8 mm long, one-nerved, the nerve hairy, margin shallowly undulate; peduncle (sub)erect, 10–30 cm long, hairy. *Flowers* \pm globose in bud, opening during anthesis and the male flowers soon falling off; perianth 5–6 mm diameter; pedicels c. 2 mm



long; tepals delicate, free, broad-ovate, creamy white, 2–3 mm long, somewhat accrescent in fruit. *Staminal ring* fused with the hypanthium; outgrowths of the connectives broad, flattish. *Ovary* undulately ribbed, as long as the perianth, c. 2.5 mm high, stigma 3- or 4-lobed, but in ageing flowers becoming entire, flat and round. *Fruit* c. 4 mm long, with 10 ribs, with faintly undulating ridges or with antler-like emergences, not extending on the persisting perianth. *Seeds* up to 60, ellipsoid, c. 1 mm long, distinctly spiny ribbed. – **Figs. 1a–e, 2a, b, 3.**

Distribution – *Malesia*: N Sumatra, southern Alas Lands; very locally.

Habitat & Ecology – Among rock blocks in damp places, up to 100 m altitude.

Fig. 3. *Pentastemona sumatrana* Steenis. Flower, c. $\times 10$ (Photograph P.J. van der Vlugt, taken from a cultivated specimen).

STEMONACEAE

(Brigitta E. E. Duyfjes, Leiden, The Netherlands)

Twining (to several metres long), trailing or erect perennial herbs, mostly with fasciculate tubers, or with a short rhizome. Plants glabrous, or with uniseriate hairs. *Leaves* papyraceous when dry, alternate, or opposite, or verticillate (China, Japan); blade (elliptic-)ovate or broad-ovate, nerves basal or lateral, curved, shallowly depressed above, secondary intervenation finely trabeculate, leaf margin entire; petiole at base pulvinate (*Stemona*), or slightly sheathing (*Stichoneuron*). *In florescences* axillary, sessile, or peduncled cincinnae, appearing as short racemes, rarely one-flowered; flowers and bracts often dotted with raphides; bracteoles absent. *Flowers* consisting of 4 similar segments, representing two rows of two tepals, these free, valvate, out-curved at anthesis, persistent; pedicel articulated. *Stamens* 4, epitepalous; filaments short, adnate to base of tepals, at base mutually free or shortly connate; anthers consisting of two ovoid or elongate thecae, each opening by a longitudinal lateral slit; the thecae situated on top of the filament, either without (*Stichoneuron*) or with an apically enlarged tepal-like appendage of the connective, moreover the connective with a median longitudinal ridge separating the thecae, the ridge either smooth and thin, or fleshy and with a brain-like wrinkled structure, the thecae themselves in addition often protruding into a common sterile appendix, 1–8 mm long, of which the tips may be fused, thus forming a crown-like structure over the stigma (*Stemona*). *Ovary* superior or half superior, small, one-celled, ovules few to many, basally (*Stemona*) or apically (*Stichoneuron*) attached, anatropous or semi-anatropous; style absent; stigma inconspicuous, roundish, papillose. *Fruit* a 2-valved capsule; seeds few to many, broad-ellipsoid, faintly or conspicuously longitudinally ridged; funicle long, with a coralloid, or lobed, hollow, wide-celled aril (*Stemona*), or aril in the form of uniseriate hairs (*Stichoneuron*). Endosperm present.

Taxonomic position — An isolated family because of various special morphological features of the flower. Its affinity has generally been accepted as being with the *Liliaceae* s.l., although not closely. Burkill (1960) and Ayensu (1964) suggested an affinity with *Dioscoreaceae*.

References: Ayensu, E.S., Bot. Gaz. 129 (1968) 160–165. — Burkill, I.H., J. Linn. Soc. Bot. 56 (1960) 319–412. — Dahlgren, R.M.T., H.T. Clifford & P.F. Yeo, The families of the Monocotyledons (1985) 121. — Duyfjes, B.E.E., Blumea 36 (1991) 239–252. — Krause, K., in A. Engler, Nat. Pflanzenfam. ed. 2, 15a (1930) 224–227. — Prain, D., J. As. Soc. Beng. 73 (1904) 39–44. — Rogers, G.K., J. Arnold Arbor. 63 (1982) 327–336. — Steenis, C.G.G.J. van, Blumea, 28 (1982) 151–163.

Distribution — Three genera, two of which occur in Indo-Malesia; *Stemona* (c. 20 species) occurs in Japan and Continental Asia, extending through Malesia to northern Australia, *Stichoneuron* (2 species) in continental SE Asia and the Malay Peninsula. The genus *Croomia* (c. 3 species) has a disjunct distribution in eastern China, southern Japan, and SE United States (Florida, Georgia). The genus *Pentastemona*, described by Van Steenis (1982) in *Stemonaceae*, has been removed from this family and raised to family-rank (see under *Pentastemonaceae*).

Habitat & Ecology — Members of *Stichoneuron* and *Croomia* are small, delicate forest dwellers at low altitudes. *Stemona* species mostly prefer a seasonal climate and can be found in rather dry places, often rocky habitats and in seasonal forests, generally not very far from the coast, at altitudes below 500 m.

Floral morphology — The early development of the stamens in *Stemona* and *Stichoneuron* is similar in spite of significant differences in the adult stages. A thorough comparison of the floral morphology of *Stemona*, *Stichoneuron* and *Pentastemona* (see *Pentastemonaceae*, p. 395) supports the exclusion of the genus *Pentastemona* from *Stemonaceae*.

Reference: Heel, W.A. van, *Blumea* 36 (1992) 481–499, pl. 1–5.

Seeds — The seeds are distinctly ridged and have a well-developed raphe and chalaza. Dispersal is probably zoochorous.

Reference: Bouman, F. & N. Deventer, *Blumea* 36 (1992) 501–514, pl. 3–5.

Leaf anatomy — Crystals are present as styloids and raphides (*Stemona*), or as raphides only (*Croomia*). In *Stichoneuron caudatum* irregular crystalline conglomerates ('clustered needle-shaped + diamond-shaped + irregularly shaped crystals', somewhat related to raphide bundles but not identical) are present, but styloids are absent. In *Stichoneuron membranaceum* the same rather undefined crystals occur together with raphide bundles.

Reference: Baas, P., in C.G.G.J. van Steenis, *Blumea* 28 (1982) 159.

Chromosomes — *Stemona japonica*: $2n = 14$ (Suzuka & Koriba 1949); *Stichoneuron caudatum*: $2n = 18$ and *Croomia pauciflora*: $2n = 24$ (counted by Gitte Peterson, Copenhagen, unpubl.). Dahlgren et al. (1985) mentioned for the family $x = 7$.

References: Dahlgren, R.M.T., H.T. Clifford & P.F. Yeo, The families of the Monocotyledons (1985) 121. — Suzuki & Koriba, *Jap. J. Pharmacog.* 3 (1949) 68.

Palynology — Pollen grains of *Stemonaceae* are small to medium-sized (19–40 μm), ellipsoidal to spheroidal, and monosulcate or inaperturate. The exine is distinctly stratified (tectum, infratectal layer, nexine). Ornamentation is diverse. Exine thickness ranges from 0.5 to 1.5 μm at the proximal side. Pollen of the Malesian species of *Stemona* can be easily distinguished from *Stichoneuron* pollen, even with light microscopy. Exine ornamentation is rugulate to scabrate in *Stemona javanica*, *S. lucida*, *S. parviflora* and *S. tuberosa*, fossulate in *S. curtisii*, psilate/perforate in *S. australiana*, and microreticulate in *Stichoneuron*. A few *Stemona* species from Thailand (*S. kerrii*, *S. phyllantha*) may be difficult to separate because of their similar microreticulate ornamentation. *Stemona* pollen is monosulcate and *Stichoneuron* pollen is inaperturate. However, the latter frequently shows a sulcus-like crack. Pollen of *Stemona* is also distinct on account of its granular/columellate infratectal layer. In *Stichoneuron* it is columellate. Pollen of *Croomia* (SE United States, Japan, China) resembles *Stichoneuron* pollen (reticulate ornamentation, columellate infratectum, monosulcate). *Pentastemona*, formerly included in the *Stemonaceae*, is pollen-morphologically quite different from *Croomia*, *Stemona* and *Stichoneuron* (see *Pentastemonaceae*, p. 396).

References: Steenis, C.G.G.J. van, *Blumea* 28 (1982) 151–163. — Ham, R.W.J.M. van der, *Blumea* 36 (1991) 127–159.

R.W.J.M. van der Ham

Phytochemistry — As far as I am aware nothing is known about the chemistry of the genera *Pentastemona* and *Stichoneuron*. The roots of several species of *Stemona* are used in Southeast Asia, China and Japan as insecticides and therapeutical agents (e.g. Perry & Metzger 1980). The chemistry and the chemotaxonomic aspects of *Stemona* and *Croomia* were discussed twice during the past 30 years (Hegnauer 1963, 1986). In these two treatises many references are available. Subterranean parts of both genera contain several insecticidal alkaloids which represent a special type hitherto only known from these taxa. Tuberostemonin, $C_{22}H_{33}NO_4$, is the best known of the *Stemonaceae* alkaloids. It was originally isolated from roots of *Stemona tuberosa* and also occurs in other *Stemona* taxa and is accompanied by a series of biogenetically related bases. Stems and leaves of *S. japonica* yielded the alkaloids stemofoline and stemospirone and roots and rhizomes of *Croomia heterosepala* contain croomine. Recently roots of *Stemona* species growing in the Southwest of China are investigated for insecticidal and therapeutically useful alkaloids: *Stemona mairei* (Wen-Han Lin et al. 1992), *S. parviflora* (Wen-Han Lin et al. 1991, 1992), *S. sessilifolia* (Dongliang Cheng et al. 1988) and *S. tuberosa* (Gwangdong Prov.; Wen-Han Lin et al. 1992).

Hitherto *Stemonaceae* were thoroughly investigated for alkaloids only. All other classes of secondary metabolites were neglected, including their phenolic compounds. Apparently there is one exception to this statement. In 1974 isolation of three non-prenylated munduserone-type rotenoids from a Thai medicinal crude drug ascribed to *S. collinsae* was reported (Shiengthong et al. 1974); these compounds were called stemonacetal, stemonal and stemonone. Later, however, Taguchi et al. (1977) investigated the same crude drug purchased on the Bangkok market and found it to be free of alkaloids, but yielding the known rotenoid stemonacetal and a new one, clitoriacetal. These workers detected that the Thai medicinal crude drug used to treat skin diseases and called 'Non-tai-yak' or 'Non-taai-yaak' has two different botanical sources, namely roots of *Stemona burkillii*, *collinsae* and *tuberosa* on the one hand, and roots of *Clitoria macrophylla* (= *C. hanceana*) on the other; pharmacognostical investigation of their crude drug sample convinced them that they were working with roots of the papilionaceous substitute *Clitoria macrophylla*. This makes it highly probable that also Shiengthong et al. (1974) investigated *Clitoria macrophylla* and not a *Stemona* taxon. Therefore, statements that *Stemonaceae* contain rotenoids (Shiengthong et al. 1974; Hegnauer 1986; Ponglux et al. 1987) are suspicious.

Saponins were recorded for roots of *S. cochinchinensis* which also contain alkaloids. Unfortunately the chemistry of these saponins is still unknown. If *Stemonaceae* are remotely connected with *Dioscoreaceae* (e.g. Van Steenis 1982) or belong to *Asparagales* (Huber 1991) one would guess that *Stemona* saponins are of the steroidal type, i.e. have a C_{27} -sapogenin.

References: Cheng Dongliang et al., J. Nat. Prod. 51 (1988) 202. — Hegnauer, R. Chemotaxonomie der Pflanzen 2 (1963) 150, 436–439, 495; *ibid.* 7 (1986) 771–773. — Huber, H., Angiospermen. Leitfaden durch die Ordnungen und Familien der Bedecktsamer (1991), G. Fischer, Stuttgart. — Lin Wen-Han et al., Roy. Soc. Chem. Nat. Prod. Updates No 10684 (1991); No 13445 (1992) (*Stemona parviflora*); No 13740 (1992) (*Stemona mairei*). — Lin Wen-Han et al., J. Nat. Prod. 55 (1992) 571 (*Stemona tuberosa*). — Perry, L.M. & J. Metzger, Medicinal plants of East and Southeast Asia (1980), MIT Press, Cambridge,

Mass. (*Stemonaceae*, p. 397). — Ponglux, D., et al. (comp.), Medicinal plants (1987), Princess Congress I, Bangkok (*Stemona*, p. 243). — Shienthong, D., et al., Tetrahedron Letters (1974) 2015. — Steenis, C.G.G.J. van, Blumea 28 (1982) 151. — Taguchi, H., et al., Chem. Pharm. Bull. 25 (1977) 1026.

R. Hegnauer

KEY TO THE GENERA

- 1a. Leaves with basal nerves only. Anther dorsally attached to the base of long, petal-like outgrowth of the connective. Ovules rather numerous, inserted at the base of the ovary **Stemona** (p. 402)
- b. Leaves with lateral nerves. Anther at the top of short filament, without outgrowth of the connective. Ovules few, apically inserted **Stichoneuron** (p. 408)

STEMONA

Stemona Lour., Fl. Coch. 1 (1790) 404; C.H. Wright, J. Linn. Soc. Bot. 32 (1896) 490; Prain, J. As. Soc. Beng. 73 (1904) 39; Merr., Enum. Philipp. Flow. Pl. 1 (1923) 202; Schltr., Notizbl. Berlin-Dahlem 9 (1924) 190; Bot. Jahrb. 59 (1925) 541; J.J. Smith, Bull. Jard. Bot. Buitenzorg III, 6 (1924) 73; Telford, in Fl. Austral. 46 (1986) 177. — Type species: name conserved.

Twining non-woody climbers, or trailing (N Australia) or erect herbs, mostly with perennial tubers. *Leaves* alternate, opposite, or verticillate (China, Japan); blades with curved basal nerves only; petioles not sheathing. *Inflorescences* sessile or peduncled, raceme-like, rarely one-flowered. *Flowers*: perianth small to rather large, tepals to 6 cm long, spreading at anthesis, the inner two petals slightly wider than the outer ones. *Anthers* with the thecae dorsally attached to the base of a long petaloid outgrowth of the connective, the thecae apically with or without a (conspicuous) common subulate appendix; filaments proportionally short, mostly connate, forming a ring or free. Ovary superior. *Fruit* pendulous, capsular, opening with two valves, few- to many-seeded. *Seeds* basally inserted, dangling on long funicles, with a coralloid or lobed, hollow aril. — **Figs. 1, 2.**

Distribution — Japan, Continental Asia, through Malesia to northern Australia; in *Malesia*: 5 species, apparently confined to coastal areas and areas with a more or less monsoon climate.

Note — The frequently purplish and greenish flowers have an unpleasant smell and may attract insect pollinators.

KEY TO THE SPECIES

- 1a. Leaves in distal parts of shoots all opposite; basal leaves often alternate **5. S. tuberosa**
- b. Leaves alternate, rarely some leaves (sub)opposite 2
- 2a. Inflorescence peduncled 3
- b. Inflorescence sessile 4

3a. Thecae with an appendix (excluding the outgrowth of the connectivum)

4. *S. lucida*

b. Thecae without an appendix (excluding the outgrowth of the connectivum)

2. *S. curtisii*

4a. Ridge separating the thecae irregularly undulate and fleshy 1. *S. australiana*

b. Ridge separating the thecae smooth and thin 3. *S. javanica*

1. *Stemona australiana* (Benth.) C.H. Wright, J. Linn. Soc. Bot. 32 (1896) 496; Telford, in Fl. Austral. 46 (1986) 178. — *Roxburghia javanica* ? *australiana* Benth., Fl. Australiensis 7 (1878) 1. — Type: *Armstrong* 628, Port Essington (K holo, in Hb. Hookerianum).

Stemona versteegii Schltr., Bot. Jahrb. 59 (1925) 542. — Type: *Versteeg* 1913, Merauke (BO holo).

Slender glabrous twiner up to 2 m. *Roots* tuberous, dark brown, 2–10 cm long. *Leaves* alternate; blade lanceolate 8–14 by 1–5.5 cm, base cuneate, rounded, or shallowly cordate, apex acute, nerves 3–5; petiole 0.5–2.5 cm long. *Inflorescence* sessile, 1–8-flowered, usually one or two flowers in full bloom, bracts parchment-like, c. 2 mm long. *Flowers*: pedicel 5–40 mm long; tepals blackish-red or dark purple, 8–10 by c. 2 mm. *Stamens* c. 8 mm long; anthers 2–3.5 mm long, the ridge separating the thecae fleshy, brain-like structured, fissured and with bulging surface; appendix of thecae absent, staminode-like, or very short, up to 2 mm long. *Fruit* 10–15 by 5–10 mm, with a beak c. 3 mm, 1–6-seeded. *Seeds* elongate, rounded at the apex, 6–8 by 2–4 mm, the base surrounded by an aril consisting of hollow, finger-like appendages.

Distribution — Australia (Northern Territory and N Queensland); in *Malesia*: Irian Jaya (near Merauke); Papua New Guinea (S coast).

Habitat & Ecology — In savanna and savanna forest, semideciduous bush, in *Imperata* fields; in N Queensland in the margin of rain forest and in coastal forest on sandy laterite; altitude sea level to c. 120 m.

Notes — According to the herbarium material seen, the inflorescences regularly produce fruits.

Superficially *S. australiana* resembles *S. javanica*, but the outgrowth of the connectivum separating the thecae in *S. australiana* is fleshy and of a brain-like structure whereas in *S. javanica* it is membranous and smooth.

Brass 6039 recorded the species as rare on Daru Island. This also holds true for Papua New Guinea and Irian Jaya. Of the seven collections from these areas only one is collected after World War II.

2. *Stemona curtisii* Hook. f., Fl. Brit. India 6 (1892) 298; Curtis Bot. Mag. 48 (1892) t. 7254. — Type: *Curtis* 1522, Penang, waterfall (K holo).

Stemona minor Hook. f., Fl. Brit. India 6 (1892) 298, p.p. — Lectotype: *Glenie* in Hb. Thwaites 3775, Ceylon, Trincomalee, see note.

Stemona tuberosa auct. non Lour.: Ridley, Mat. Fl. Mal. Penins. 2 (1907) 86.

Glabrous twiner up to 3 m. *Roots* tuberous, c. 10 cm long, forming a bundle. *Leaves* alternate, seldom opposite; blade ovate-oblong, 6–21 by 2.5–10 cm, base sometimes shallowly, but more often broadly cordate, apex c. 2 cm acuminate, nerves 11–15; petiole 4–8.5 cm long. *Inflorescence* 2–many-flowered, on a peduncle 2.5–10 cm, not fused with the petiole; bracts narrow, 6–10 mm long. *Flowers* pendent; pedicels 8–10 mm long; tepals pink, brown pink or dark brownish red, 17–22 mm long. *Stamens* 13–18 mm long; anthers 7–10 mm long, the thecae proceeding as sterile ridges up to the top of the tepaloid outgrowth of the connectivum, and separated by a smooth projecting ridge, 1–1.5 mm high, equally tapering off towards the top of the tepaloid connectivum. Additional appendix of the thecae absent. *Fruit* 25–30 by c. 15 mm, shortly beaked, 2–6-seeded. *Seeds* 18–20 by 3–3.5 mm, the acuminate apex c. 5 mm, the base enveloped by an aril consisting of hollow, finger-like appendages.

Distribution — Sri Lanka (rare), Thailand; in *Malesia*: Malay Peninsula (Lepar Archipelago near Banka; one collection seen).

Habitat & Ecology — At low altitudes, not far from the coast, on sand and limestone; found near the shore, on riverbanks, near waterfalls, in thickets and scrub, also in secondary growth in rubber plantations.

Notes — The flowers of *S. curtisii* and *S. collinsae* Craib (Thailand) are identical, but *S. curtisii* is a rather tall climber while *S. collinsae* is a low, erect herb.

Ridley l.c. mentions opposite as well as alternate leaves in the same plant, but the occurrence of opposite leaves is rare; I have seen it in only one collection, *Ridley* 10305.

Stemona minor is based on three collections: Wight 2821, which is *S. tuberosa*, the above mentioned collection Glenie in Hb. Twaites 3775 which is *S. curtisii*, and Beddome 770 in BM., the latter not seen.

3. *Stemona javanica* (Kunth) Engler in Engler & Prantl, Nat. Pflanzenfam. II, 5 (1878) 8; C. H. Wright, J. Linn. Soc. Bot. (1896) 495; J. J. Smith, Ic. Bog. 3 (1907) 107, t. 244; Backer & Bakh. f., Fl. Java 3 (1968) 154. — *Roxburghia javanica* Kunth, En. Pl. 5 (1850) 288. — Type: Zollinger *Plantae Javanicae* 2441 (BM holo).

Stemona asperula J. J. Smith, Bull. Jard. Bot. Buitenzorg III, 6 (1924) 76. — Syntypes: *Beguín* 2333, 2338 (both Halmahera).

Stemona sulensis J. J. Smith, Bull. Jard. Bot. Buitenzorg III, 6 (1924) 78. — Type: *Hulstijn* (*Atje*) 182, Mangoli Island (BO holo).

Stemona papuana Schltr., Bot. Jahrb. 59 (1925) 542. — Type: *Peekel* 839, New Ireland (Neu Mecklenburg), Lemakot (B holo).

Glabrous, or slightly asperulous (Halmahera), twiner, up to 5 m. *Roots* tuberous. *Leaves* alternate; blade ovate or broadly ovate 6–18 by 2–12 cm, base cuneate to deeply cordate, nerves 7–11; petiole 1.5–6 cm long. *Inflorescence* sessile or subsessile, (1- or) few-many-flowered, bracts parchment-like 1.5–3 mm long, imbricately arranged and finally forming a pseudo-peduncle up to 1.5 cm long. *Flowers*: pedicel 1–4 cm long; tepals dark purple or purple-brown, 8–12 by 2–4 mm. *Stamens* purple or dark brown, c. 8 mm long; anthers 2–2.5 mm long, the thecae separated by a c. 1 mm high, wing-like ridge; appendix of thecae 0.5–1.5 mm long, fused at the tips, or appendix staminode-like, c. 1 mm long, not fused. *Fruit* 15–35 by c. 10 mm, beak c. 4 mm, 3–7-seeded. *Seeds* elongate, rounded at the apex, 5–16 by 2–4 mm, funicle c. 6 mm long, with an aril consisting of many translucent, hollow, finger-like appendages, reaching to the base of the seed.

Distribution — *Malesia*: S coast of Java, Halmahera, Sula Islands (Mangoli, Sanana), NE Irian Jaya, N Papua New Guinea, S coast of New Britain, and W New Ireland.

Habitat & Ecology — Apparently occurring only along and near the coast, up to 300 m altitude. In Java on sandy and rocky beaches, coastal forest (*Barringtonia*-formation), scrub vegetation, river borders and devastated forest. In the Sula Islands on karang (limestone) and in ladangs; in Halmahera, Irian Jaya and Papua New Guinea in rather open

primary forest, mixed lowland rain forest, forest edges, secondary forest and grassland.

Notes — The flowers have an unpleasant smell.

In Halmahera, Weda District, extract from the stem is given as a drink after childbirth for purification. In Sula Sanana (Moluccas) the tubers are used as fish-poison (*Bloembergen* 4372).

Specimens cultivated in the botanical garden at Bogor (origin not indicated) have whitish tuberous roots.

Some specimens from Halmahera have slightly asperulous stems and petioles.

4. *Stemona lucida* (R. Brown) Duyfjes, Blumea 36 (1991) 243. — *Dioscorea lucida* R. Brown, Prod. (1810) 295. — Type: *Banks & Solander s.n.*, Endeavor R., Queensland (BM holo; left-hand specimen).

Stemona philippensis Merr., Bull. Philipp. Gov. Lab. 6 (1904) 16; Telford, in Fl. Austral. 46 (1986) 178. — Type: *Merrill* 3061, Philippines, Masbate Island (K holo).

Slender, glabrous twiner, up to 7 m. *Roots* tuberous. *Leaves* alternate; blade variable in shape, ovate, lanceolate, hastate, or linear, 4–14 by 0.5–9 cm, with deeply cordate, truncate or narrowed base, nerves 3–11; petiole 1–3 cm long. *Inflorescence* 3-many-flowered; peduncle 1–9 cm long, not fused with the petiole; bracts 2–5 mm long, rather membranous. *Flowers*: pedicel 0.3–0.5 cm long; tepals dark purple, 8–14 by 2–3.5 mm. *Stamens* 8–12 mm long; anthers c. 3 mm long, ridge separating the thecae smooth; appendix of thecae 1.5–4 mm long, fused at the tips. *Fruit* 8–20 by 7–12 mm, c. 0.6 mm beaked, 2–9-seeded. *Seeds* elongate, rounded at the apex, 10 by 4 mm, surrounded at the base by a vesicular aril, c. 4 mm long.

Distribution — Australia (northern Queensland, Cook District); in *Malesia*: Philippines (Masbate, Ficao); Papua New Guinea (Normanby Island, Milne Bay Prov., Central Prov. in the surroundings of Port Moresby).

Habitat & Ecology — Rather dry places in monsoon areas, not far inland, in scrub, open forest, dry gallery forest, and on roadsides; at an altitude of 0–200 m.

Notes — The type material in BM exists of two specimens, belonging to different species. The left-hand specimen, the holotype, bears no flowers, but the two peduncles with the characteristic persisting pedicels leave no doubt about its identity. The right-hand specimen, which is sterile and without peduncles, is probably *S. australiana*.

Wright, in J. Linn. Soc. Bot. 32 (1896) 495, placed *Dioscorea lucida* in *S. javanica*. Telford (l.c.: 180) put it aside in *Stemona* as a doubtful name, because of an sterile isotype seen by him in NSW.

The inflorescences of the juvenile specimen in the collection *Blake 14540*, Queensland (Cook District), are situated in the lower part of the stem, in the axils of c. 5 mm long cataphylls. These leaves gradually change higher up the stem into lanceolate and hastate leaves.

5. *Stemona tuberosa* Lour., Fl. Coch. 1 (1790) 404, but cited literature p.p.; C.H. Wright, J. Linn. Soc. Bot. 32 (1896) 494. — Type: A specimen not found; lectotype: Rumph., Herb. Amb. 5 (1747) 365 "Ubi Gorita nigrum", with illustration t. 129.

Roxburghia gloriosoides Roxb., Pl. Corom. 1 (1795) 29, t. 32; Blume, En. Pl. Jav. 1 (1830) 9 ('*Roxburgia*'), for the description, the cited literature p.p. — Type: not known.

Roxburghia viridiflora J. Smith, Exot. Bot. 1 (1804/05) 111. — Type: *Wallich 5156* (K holotype).

Roxburghia gloriosa Pers., Syn. Pl. 1 (1805) 412; Curtis Bot. Mag. 35 (1812) t. 1500; J.J. Smith, Bull. Jard. Bot. Buitenzorg III, 6 (1924) 75. — Type: not known.

Glabrous twiner to 4 m. *Roots* forming a fascicle of many thick, fleshy, yellow or black tubers, up to c. 10 cm long. *Leaves* opposite, but those in proximal part of shoots often alternate; blade ovate or broadly ovate, 9–19.5 by 3–14 cm, base shallowly cordate or cordate, top acuminate, nerves 9–13; petiole 1.5–7 cm long. *Inflorescence* (1–)2–6-flowered; peduncle 2–8 cm long, free or fused with the petiole for 5–30 mm; bracts 5–15 mm long. *Flowers*: pedicels 5–15 mm long; tepals outside green or yellow-green with dark green or purple stripes, green towards the tips, purple or brown-red inside with wine-red stripes, 25–50 by 4–10 mm. *Stamens* purple, 25–40 mm long; anthers 8–15 mm long, thecae separated by a 1–1.5 mm high and smooth ridge; appendix of thecae 5–12 mm long, tips fused. *Fruit* green, pendent, 40–70 by 15–20 mm, 10–20-seeded. *Seeds* 9–17 mm long, acumen c. 4 mm, funicle c. 8 mm long, the base surrounded by a vesicular aril. — **Figs. 1, 2.**

Distribution — Widespread; for details see under the varieties.

KEY TO THE VARIETIES

- 1a. Peduncle of the inflorescence axillary, free, not fused with the petiole **a. var. *tuberosa***
- b. Peduncle of the inflorescence fused with the petiole for 5–30 mm . . . **b. var. *ternatensis***

a. var. *tuberosa*

Distribution — SE Continental Asia, Taiwan, Hainan; in *Malesia*: Philippines, Flores, Ambon.

Notes — For discussion and typification of the name *S. tuberosa*, see under var. *ternatensis*.

Apparently the type variety is rather rare in the Lesser Sunda Islands and Moluccas; from Flores I have seen only four collections. The species is described by Rumphius from Ambon, but later collections are unknown.

b. var. *ternatensis* (J.J. Smith) Duyfjes, Blumea 36 (1991) 243. — *Stemona moluccana* (Blume) C.H. Wright var. *ternatensis* J.J. Smith, Bull. Jard. Bot. Buitenzorg III, 6 (1924) 73. — Type *Beguín 1682*, Ternate (BO holotype). — **Figs. 1, 2.** *Roxburghia moluccana* Blume, Fl. Jav. 1 (1827) 9 ('*Roxburghia*'), for the description only. — *Stemona moluccana* (Blume) C.H. Wright, J. Linn. Soc. Bot. 32 (1896) 494; J.J. Smith, Ic. Bogor. 3 (1907) 111, t. 245, 246. — Type: not known. *Stemona affinis* J.J. Smith, Bull. Jard. Bot. Buitenzorg III, 6 (1924) 74. — Type: *Beguín 1960*, Halmahera (BO holotype).

Distribution — *Malesia*: Philippines, Bali (sterile), Lombok, Flores, Timor, Wetar, Jamdena I., Morotai, Halmahera, Ceram, Buru (sterile), Ambon, Irian Jaya (western part).

Habitat & Ecology — At low altitudes not far from the coast; found on loamy soils and sandy tuff; beach vegetation, coastal forest, undergrowth in thick scrub, primary forest along rivers, and on cultivated ground.

Pollination — Probably by small flies, belonging to the family *Longhaeiidae*.

Taxonomy — Variety *ternatensis* seems related to *Stemona phyllantha* Gagnep., Bull. Soc. Bot. Fr. (1934) 147, from Thailand, but differs by the peduncle being partly fused with the petiole, and by a large perianth, with the tepals 60 mm or longer.

Uses — No uses are mentioned on the field labels, but Rumphius, l.c., gives extensive data on medicinal properties.

Notes — Loureiro added to the description of *Stemona tuberosa* only one reference: "Rumphius



Fig. 1. *Stemona tuberosa* Lour. var. *ternatensis* (J.J. Smith) Duyfjes. a. Leaf, $\times 0.5$; b. inflorescence, the peduncle partly fused with the petiole, $\times 1$; c. androecium, $\times 1$, d. front and lateral view of stamen, $\times 2.5$ (after Icones Bogoriensis).

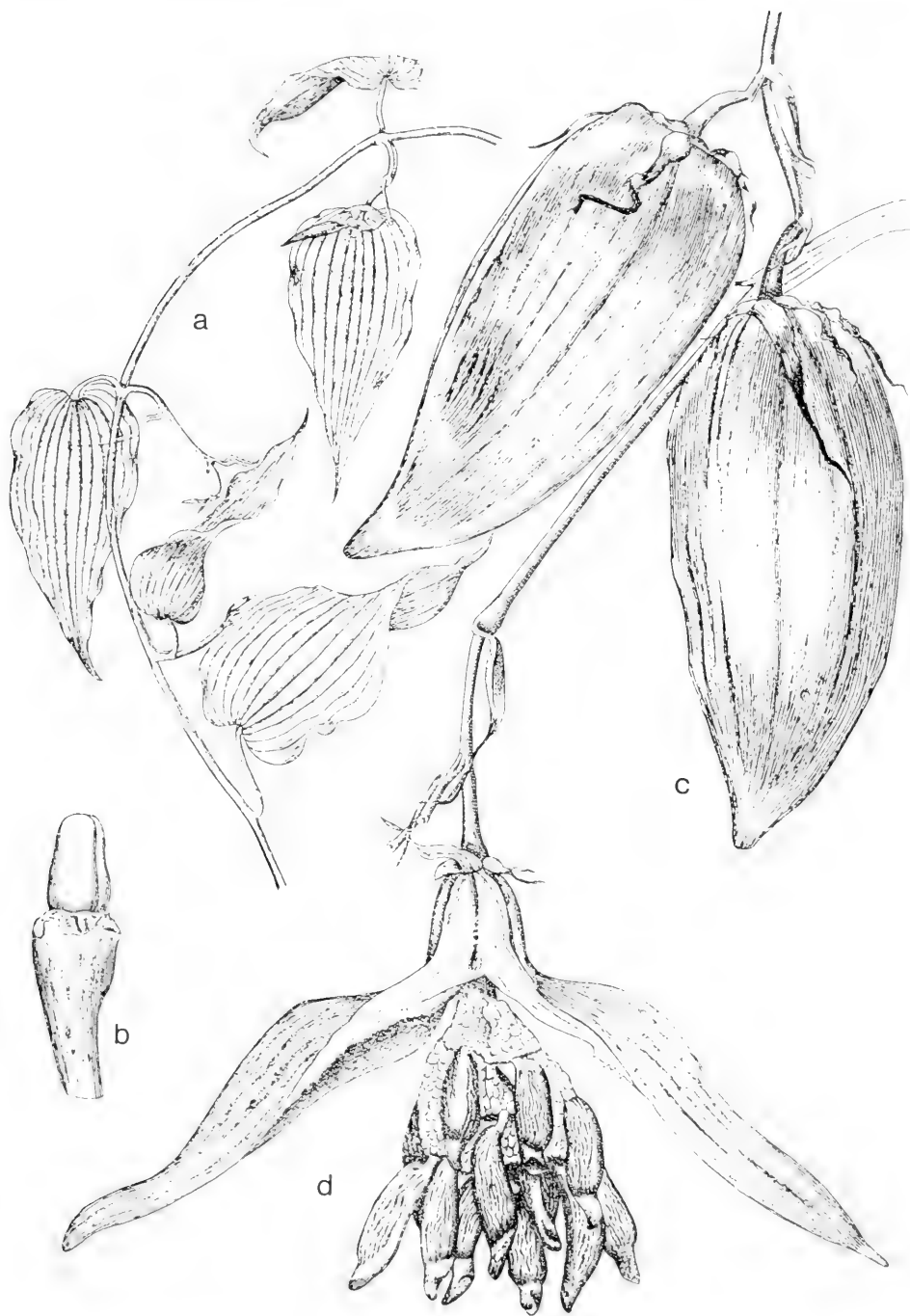


Fig. 2. *Stemona tuberosa* Lour. var. *ternatensis* (J.J. Smith) Duyfjes. a. Leafy stem, $\times 0.25$; b. pedicel with ovary (tepals and stamens removed), $\times 3$; c. fruits, $\times 1$, d. dehiscent fruit, $\times 1$ (after Icones Bogoriensis).

Ubium Polypoides, t. 129". There has been confusion in the interpretation of Rumphius' *Ubium Polypoides* or *Ubi Gorita*. Rumphius distinguished in *Ubium Polypoides* two taxa, viz.: "Album, seu vulgare *Ubium Gorita*" (*Ubium* with the white tuberous roots), and "Ubi Gorita nigrum" (*Ubium* with the black tuberous roots). The first, "Album, seu vulgare *Ubium Gorita*" is characterized i.a. by the peduncle being partly fused with the petiole. The habitats of this *Ubium* are given in detail, and it is evident that this taxon is the same as the present *S. tuberosa* var. *ternatensis*, which is a common plant in the Moluccas. The second, "Ubi Gorita nigrum", clearly depicted on table 129, is characterized i.a. by the peduncle emerging from the leaf-axil, not fused with a part of the petiole. Of this *Ubium* Rumphius noted that it is found much less frequently than the *Ubium* with the

white tuberous roots. "Ubi Gorita nigrum" is the same taxon as *S. tuberosa* var. *tuberosa*, which was, as far as is known, never collected on Ambon after Rumphius' time. As the type of *S. tuberosa* could not be traced, I have indicated table 129, with the appropriate description, as lectotype of *S. tuberosa* var. *tuberosa*.

According to *Beguin 1725* from Halmahera, the plant has a bunch of thick fleshy roots, as also described by Rumphius, l.c. According to the label of *Museumtuin no 991* (ex Ambon) the roots are yellow on the outside and white within.

Rumphius, l.c., wrote that in young plants the leaves are alternate, in older plants opposite.

Flowers and open fruits have a disagreeable fetid odour and the plant, when crushed, has an unpleasant smell. *Miller NGF 9712* noted skin irritation caused by sap of the plant.

STICHONEURON

Stichoneuron Hook. f. in Benth. & Hook. f., Gen. Pl. 3 (1883) 747. — Type species: *Stichoneuron membranaceum* Hook. f.

Erect, low, herbs with short rhizomes, probably dioecious. *Leaves* alternate; blades with curved lateral nerves; petioles slightly sheathing at base. *Inflorescences* raceme-like, short, with densely set stiff pedicels. *Flowers* small with recurved tepals. *Stamens* free, simple, without appendages, filaments longish, apically bearing an anther consisting of two dorsifixed thecae without appendage. *Ovary* semi-inferior, one-celled, ovules few, anatropous, apically attached. *Fruit* with one or two seeds. *Seeds* with a funicle, with a flimsy aril consisting of uniseriate hairs. — **Figs. 3, 4.**

Distribution — There are 2 species, *S. membranaceum* in SE Asia, India (Assam), and *S. caudatum* in Thailand and in *Malesia*: Malay Peninsula.

Stichoneuron caudatum Ridley, J. Str. Br. Roy. As. Soc. 57 (1911) 107; Steenis, Blumea 28 (1982) 151, f. 2c, e, f. — Type: *Ridley 14582* (SING holo).

Slender, erect herbs, up to 60 cm, with few branches; stem, pedicels and leaves on lower surface hairy. *Leaves* alternate; blade elliptic, 7–12 by 2–5.5 cm, base rounded or cuneate, apex acuminate; petiole 0.5–1 cm long. *Inflorescence* few- or densely-flowered, with mostly one or two flowers in anthesis; bracts hyaline, c. 2 mm long, margins fringed. *Flowers* 6–8 mm in diameter (but see note); pedicel filiform and stiff, 3–10 mm long; tepals dull violet or reddish purple, c. 5 mm long, acuminate or with a filiform appendix up to 7 mm long, the outside glabrous or sparsely hairy, the

inside glabrous, papillose, or sparsely hairy. *Stamens* 1.5–2.5 mm long; base of filaments adnate to tepals, glabrous, papillose or densely hairy; thecae without appendices. *Ovary* and style minute. *Fruit* with thin pericarp, slightly flattened, slightly curved, 11–19 by 4–6 mm, the top caudate for a few millimetres, green; perianth persistent. *Seeds* 1 or 2, broad-ellipsoid, sharply ridged lengthwise, 5–7 mm long; funicle c. 3 mm, aril consisting of 5 or 6 wide-celled appendages surrounding the seed up to halfway. — **Figs. 3, 4.**

Distribution — Thailand; in *Malesia*: Malay Peninsula.

Habitat & Ecology — Evergreen forest; on forest floor, always near water: in swampy forest, rocky streams and on riverbanks; altitude up to 200 m.



Fig. 3. *Stichoneuron caudatum* Ridley. Top of flowering shoot with two (young) inflorescences, each with one flower, $\times 2.5$ (Photograph by J. Bogner).

Uses – The leaves of this species are eaten with betel as a tonic in convalescence; the Malay name 'kayu mati hidup' or 'expectation of death'-tree, suggests an abortifacient (Burkill, Dict. Econ. Prod. Mal. Penins. ed. 2, 1966, 2120).

Notes – Herbarium material often lacks flowers, whereas fruits are known from a few collections only; the description of the fruit and seed is after Van Steenis (l.c., who obtained the data from Dr. R.E. Holttum), and from *Bogner 1789* (cult.).

The following description of the flower is based on living material, provided by J. Bogner, München: Perianth c. 6 mm long, c. 12 mm in diameter; tepals acute to acuminate, spreading, margins recurved, dirty white, the outside sparsely hairy, the inside densely set with white or carmine hairs. Stamens c. 2 mm long, filaments white, short and thick, densely beset with white or carmine hairs,

anthers free, yellow, without a conspicuous connectivum (see also Fig. 3).

Living material testifies that the petiole bases are slightly sheathing, a feature not easily seen in dried material.

Henderson (*SFN 29662*) noted that the species forms an almost pure stand as undergrowth in river-bank forest along the Gua Musang R. (Kelantan).

The flowers are rather variable: tepals may be acute or provided with a filiform appendix, the filaments and inside of tepals are densely hairy, papillose, or glabrous. The species is obviously closely related to *S. membranaceum* Hook. f., known only from a few collections in eastern India (Khasia).

All flowers seem to be hermaphroditic (but it is possible that they are functionally female or male). Field research is needed to explain the scantiness of well-developed ovaries and fruits in herbaria, suggesting poor fertility in the natural conditions.



Fig. 4. *Stichoneuron caudatum* Ridley. Older inflorescence showing the typical 'broom-like' arranged pedicels persistent after flowering; one fruit developed; $\times 1$ (Photograph by J. Bogner).

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